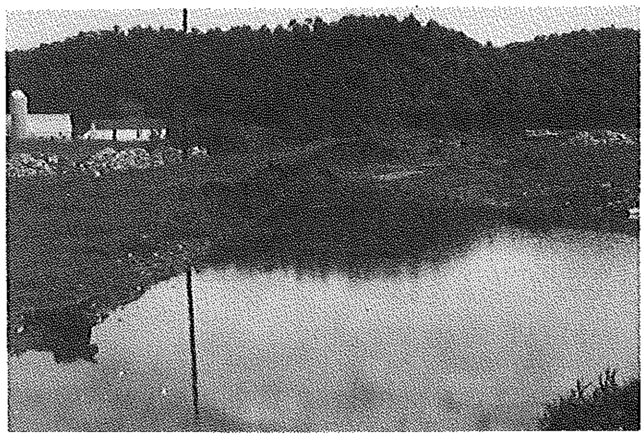
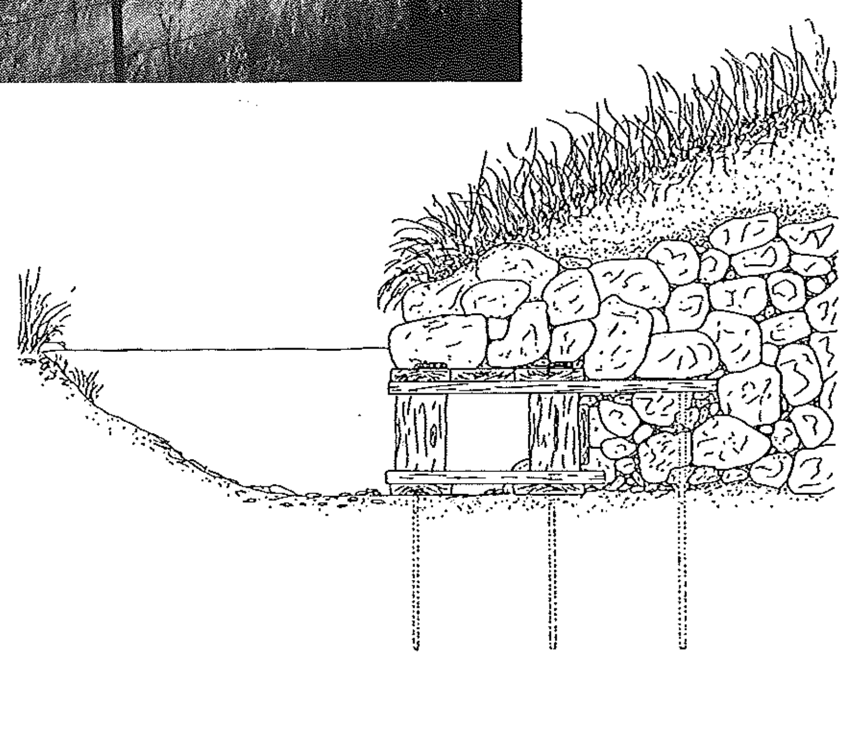
UNIT CONSTRUCTION OF TROUT HABITAT IMPROVEMENT STRUCTURES FOR WISCONSIN COULEE STREAMS

By David M. Vetrano





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CONTENTS

INTRODUCTION

Many changes have occurred in the trout habitat improvement program in the Wisconsin DNR La Crosse Area since 1982. A new structure design, the LUNKERS unit*, when combined with increased rock riprapping for bank stabilization and more extensive landscaping, has reduced the cost of the habitat improvement program by over 30%. In addition, the longevity of improvements is increased with these new structures, while maintenance needs are reduced.

The simplicity of construction and installation of the LUNKERS unit has stirred interest among private and professional organizations who want to start habitat programs in areas with similar stream types.

The purpose of this report is to aid those unfamiliar with coulee stream habitat improvement to implement, with minimum problems, a habitat improvement project using the LUNKERS design. The text includes a step-by-step description of construction and installation of the LUNKERS unit, as well as information on site preparation, materials, and the Wisconsin permit process.

BACKGROUND

Trout habitat improvement work has more than 25 years of history in the La Crosse Area. During that period, the design of the most commonly used in-stream structure has changed very little. Because of the rock-rubble bottom common to trout streams in the region, jetted post/plank structures of the type used in the sand country regions of Wisconsin could not be used. Instead, wing deflectors made of logs, wire, and rock were the structures primarily used in the La Crosse Area.

Logs cut along the stream bank were the usual source of materials for wing deflectors. Two short logs, called anchor logs, were placed in the stream perpendicular to the bank. Another log, called a face log, was placed parallel to the stream bank on top of the anchor logs. Both the anchor log and face log were then wired to steel fence posts driven into the streambed on the inside corners of the logs. The ends of the wire were anchored using fence staples. Additional logs were placed between the face log and the stream bank. A length of hog wire was then stapled to the log structure to help hold the structure together. Riprap rock was placed on top of the structure, and the area behind each structure was sloped, raked, and seeded (Fig. 1).

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*LUNKERS is an acronym for Little Underwater Neighborhood Keepers Encompassing Rheotactic Salmonids. The new unit design and the exceptional water quality of the receiving streams called for a unique name that would reflect trout response. A trip through Webster's Dictionary and an active imagination resulted in the LUNKERS name.

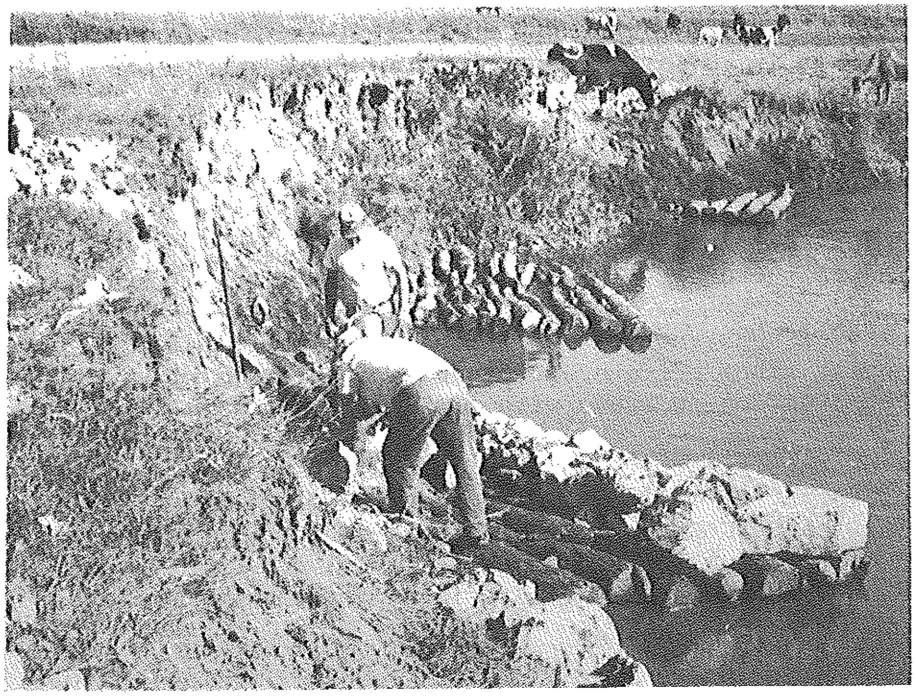


FIGURE 1. Installation of early log wing deflectors, La Crosse Area.

Besides deflecting the current, these structures provided trout with overhead cover and an area of reduced current. When used singly to deflect the current, very few problems occurred with these structures. Problems often occurred, however, when two or more deflectors were placed together on an outside bend.

The anchor logs prevented any current from flowing through the structures. Consequently, substantial deposits of silt accumulated on the downstream side of the anchor logs. In these situations, the lower structures would gradually fill in with silt and would no longer provide effective overhead cover (Fig. 2).

Other problems also occurred with these log structures. Because of the difficulty in driving fence staples under water, the structures had to be installed with the tops of all the logs right at the stream surface. Subsequent fluctuation in water levels caused by stream gradient changes exposed these logs to the air, causing them to decompose prematurely.

Installation in water more than 2 ft deep posed problems with anchoring. At that depth, two or three logs arranged into a pier had to be used. The steel fence posts were then too short to adequately anchor the structures to prevent their displacement by high water. This problem was clearly evident in 1978, when regional streams were subjected to a 100-year flood that caused extensive damage to most of the habitat work. In all, 355 wing deflectors were destroyed, and another 303 were damaged in five regional streams. During the next few years over $290,000.00 in federal disaster funds and state trout stamp funds were spent to repair structures in flood-damaged streams.

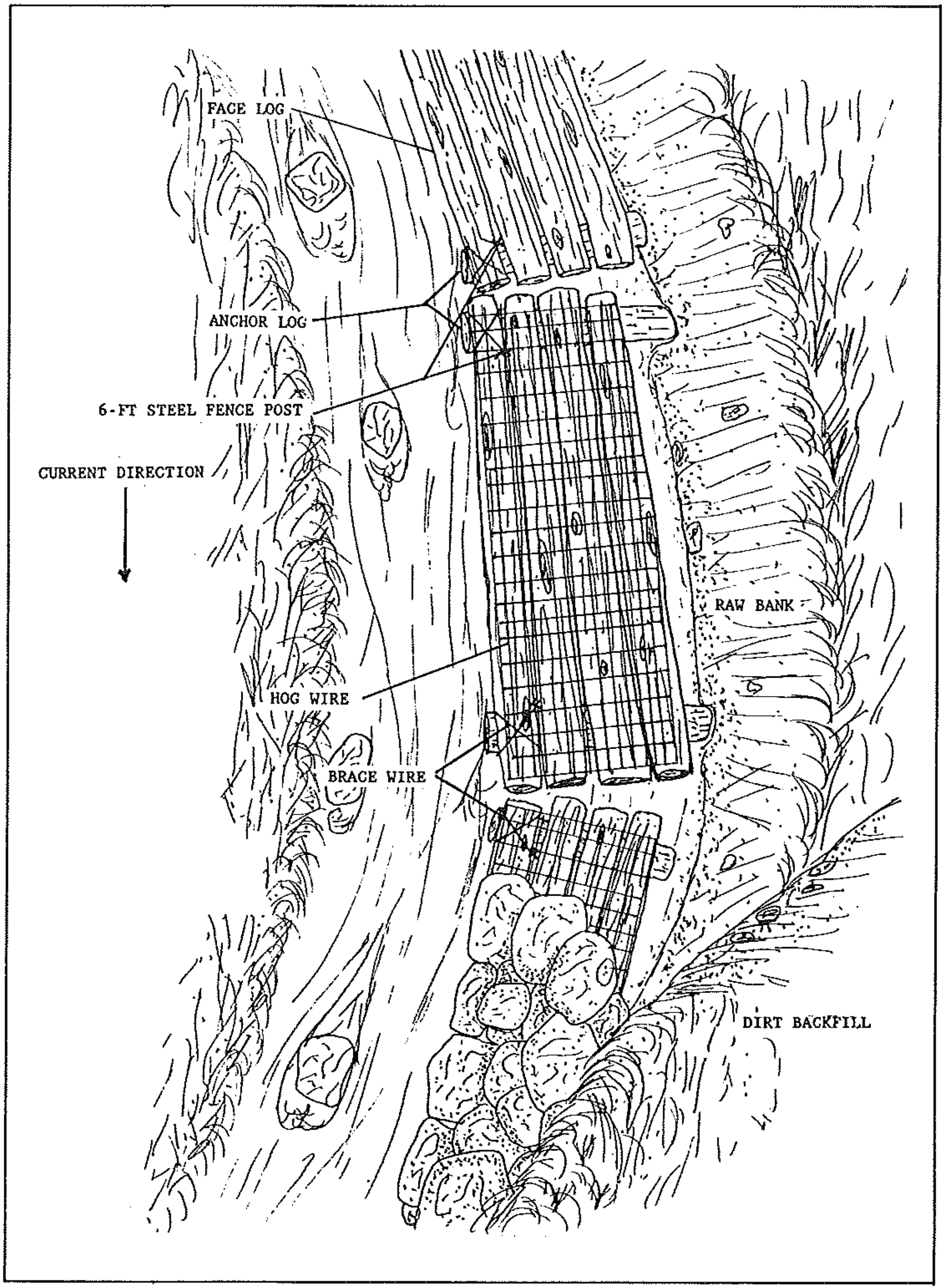


FIGURE 2. Log wing deflectors.

Additional installation problems occurred with the wing deflectors. The large size of the logs required a small tractor or some other piece of heavy equipment to move them from the stockpile to the project site. The structures then had to be custom built in the stream, one at a time, leaving some of the crew idle while the tractor operator prepared the site for installation. This delay increased the cost of each structure.

Further, insufficient attention was paid to placement of the structures and landscaping of the surrounding stream banks. In some cases, a structure installed upstream actually deflected the current away from structures below it. The lower deflectors would soon fill in with silt. Landscaping was done immediately behind each structure, but the areas between structures were left untouched, leaving large hollowed areas of stream bank that continued to erode, especially during high water. Also, since no riprapping was placed above or below structures to prevent erosion of the stream bank, during high water the stream eroded the bank behind the structures. Eventually these structures were in the middle of the stream channel.

Along with problems of installation and function, the cost of wing deflectors became prohibitive. Sufficient numbers of logs were not available locally, so oak logs were cut and hauled from the Black River Falls area, 60 miles away. Because whole logs were used, the cost of hauling was excessive. Estimates made in 1980 indicated each structure cost $419.00.

It became increasingly clear that these single-wing deflectors were neither as cost effective nor as permanent as they could or should be. In 1982 an intensive and wide-ranging period of experimentation was initiated. The goal was to design a structure that was not only easy to construct and install but would also reduce installation costs and maintenance needs.

USE OF PREBUILT HABITAT STRUCTURES

The LUNKERS unit described here is the culmination of experimentation with different structure designs. This structure is designed to survive and to function well in local coulee streams.

Instead of whole logs, brace wire, and steel fence posts, we now use oak planks, oak blocks, and reinforcing rods. Oak blocks, made from short sections of tree trunks, are used as spacers. Oak planks are nailed to the tops and bottoms of the blocks, forming stringers which tie into the stream bank at right angles. Oak planks are then nailed to the top and bottom of the stringer boards. These boards parallel the stream bank. The whole structure forms a crib, which can be constructed on shore and moved by a crawler-loader to the installation site in the stream (Figs. 3, 4, 5). The structure is anchored by driving lengths of reinforcing rod through predrilled holes in the structures and then into the streambed (Fig. 6).

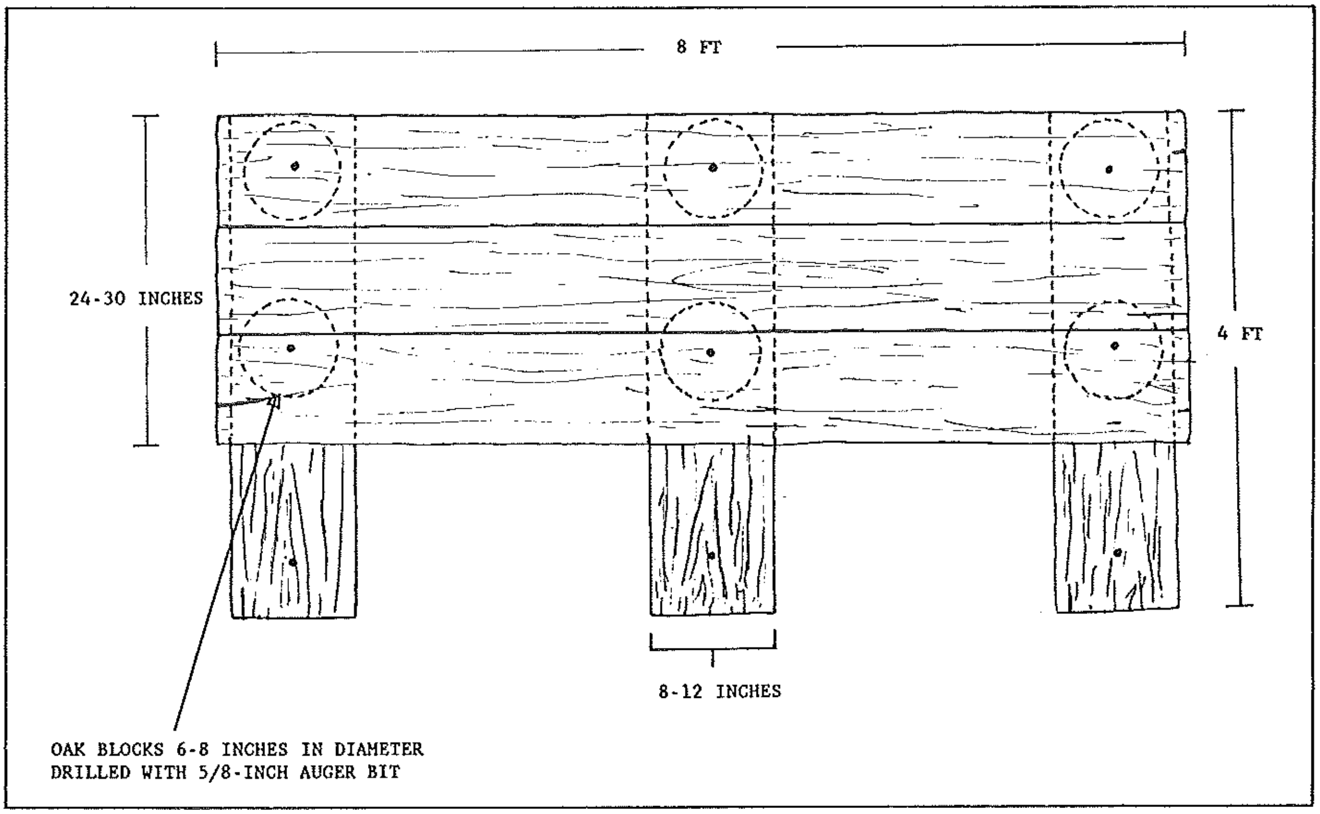


FIGURE 3. Top View, La Crosse LUNKERS unit.

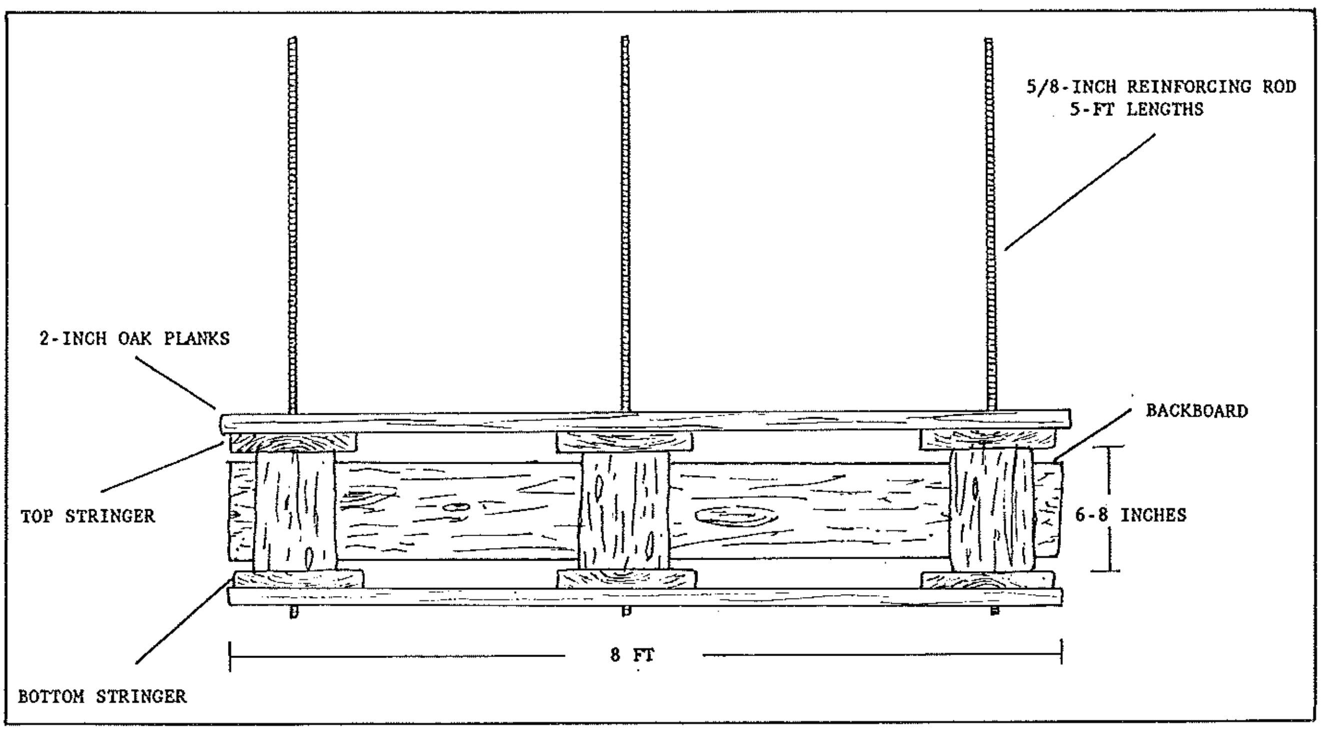


FIGURE 4. Front View, La Crosse LUNKERS unit. Structures are built using oak planks 2 inches thick by 8-12 inches wide. Structures are nailed together with 20D common spikes.

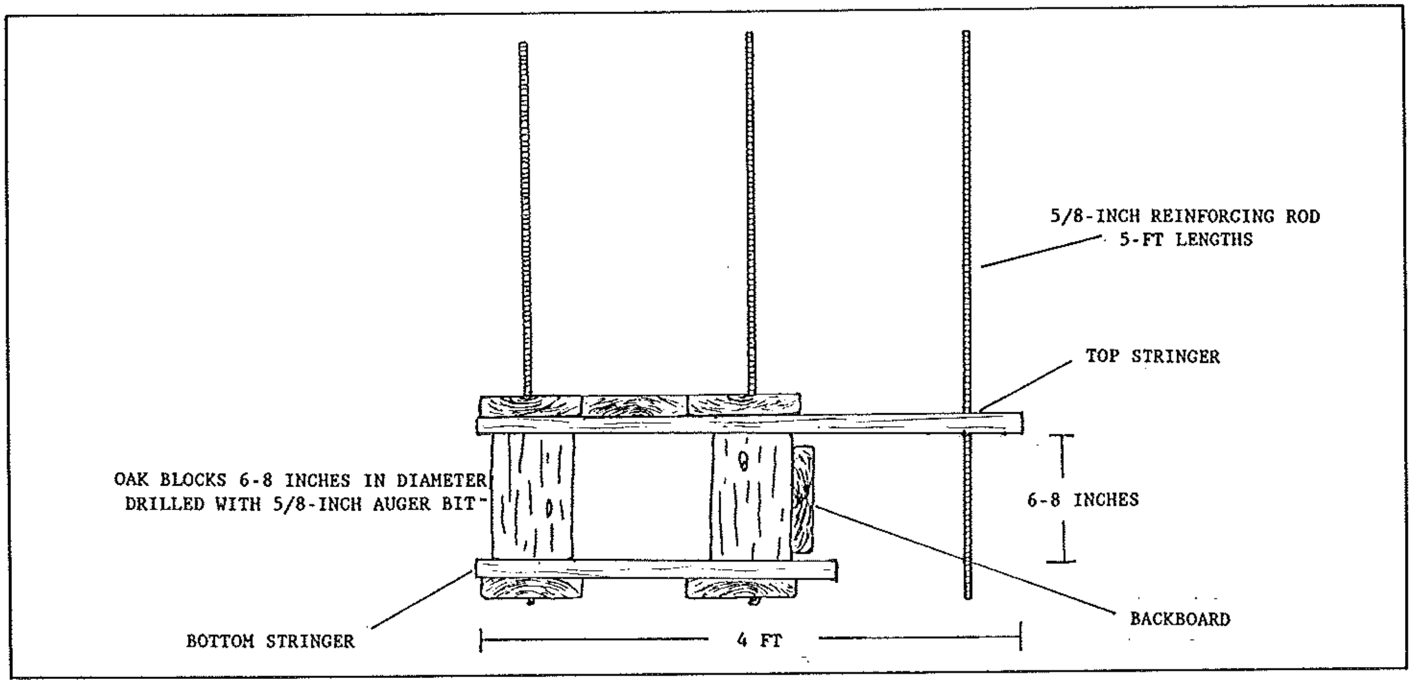


FIGURE 5. Side View, La Crosse LUNKERS unit.

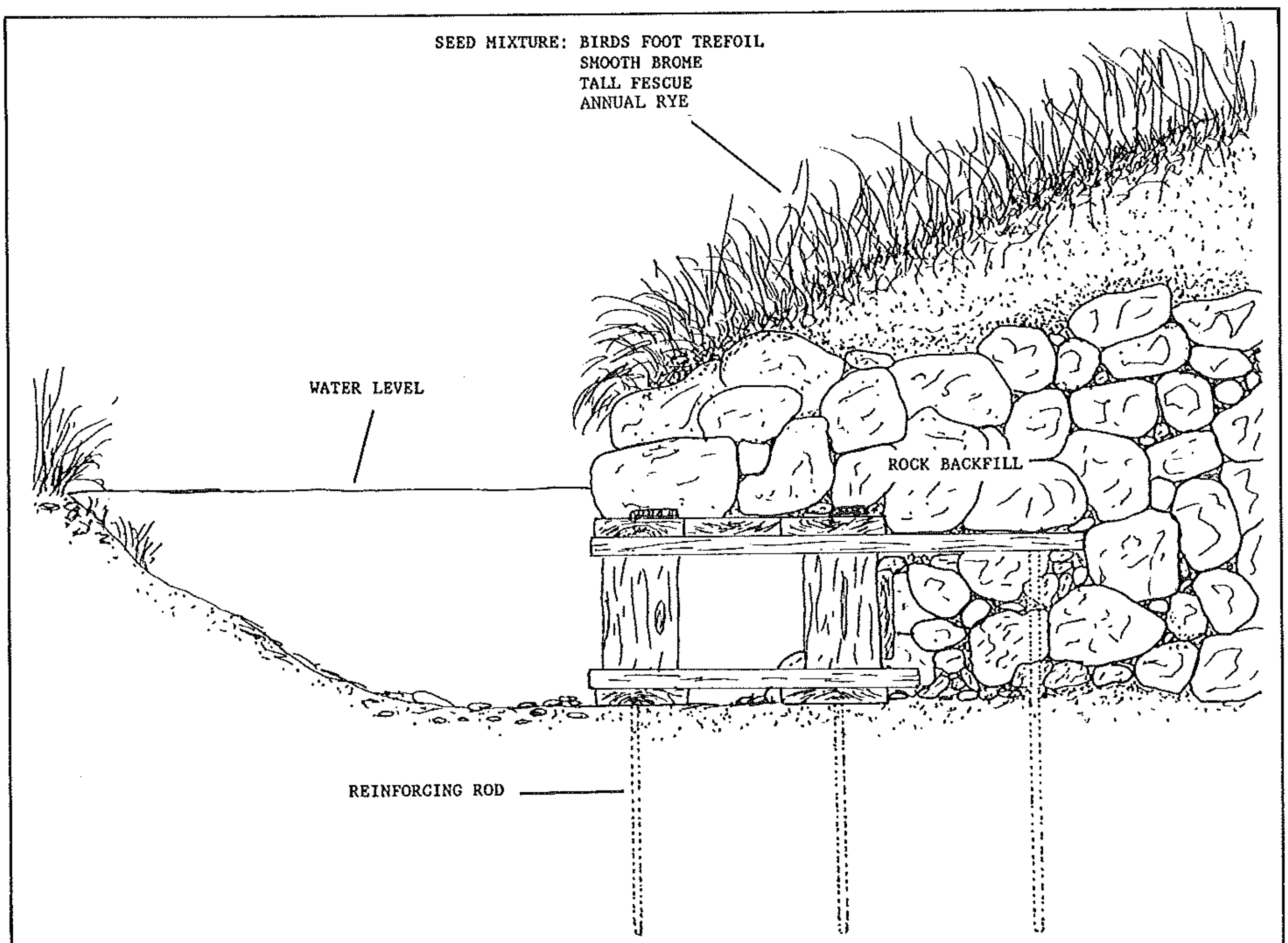


FIGURE 6. Side View, installed LUNKERS unit.

When all the materials are at hand, two experienced people can assemble and nail the structures together in 11 minutes (Fig. 7). Complete installation of 3-5 structures on an outside bend of a stream can be accomplished in about four hours with a crew of four. This includes all cutting, drilling, construction, rocking (placing face rocks and backfilling with pit run riprap), landscaping, raking, and seeding. The structures can be built near the installation site while the site is being prepared, eliminating the lag time required for installation of log structures (Fig. 8).

FIGURE 7. La Crosse Area's LUNKERS unit.

CONSTRUCTION AND INSTALLATION OF THE LUNKERS UNIT

Site Preparation and Materials

After the necessary land rights and permits are obtained, and before materials are hauled to the project site, the stream is inspected by the habitat technician and the crew leader. If possible, the landowner is also included in this process. Each site is evaluated for placement of structures, number of structures needed, and the amount of landscaping required to adequately protect the site during high-water periods. Survey flags are used to indicate where rock is to be stockpiled. The flags can be marked with a permanent marker pen to indicate the number of rock loads needed. Access roads are planned and built, and culverts are installed where required to cross springs and small stream tributaries. The culverts are left permanently in place to allow future access for maintenance.

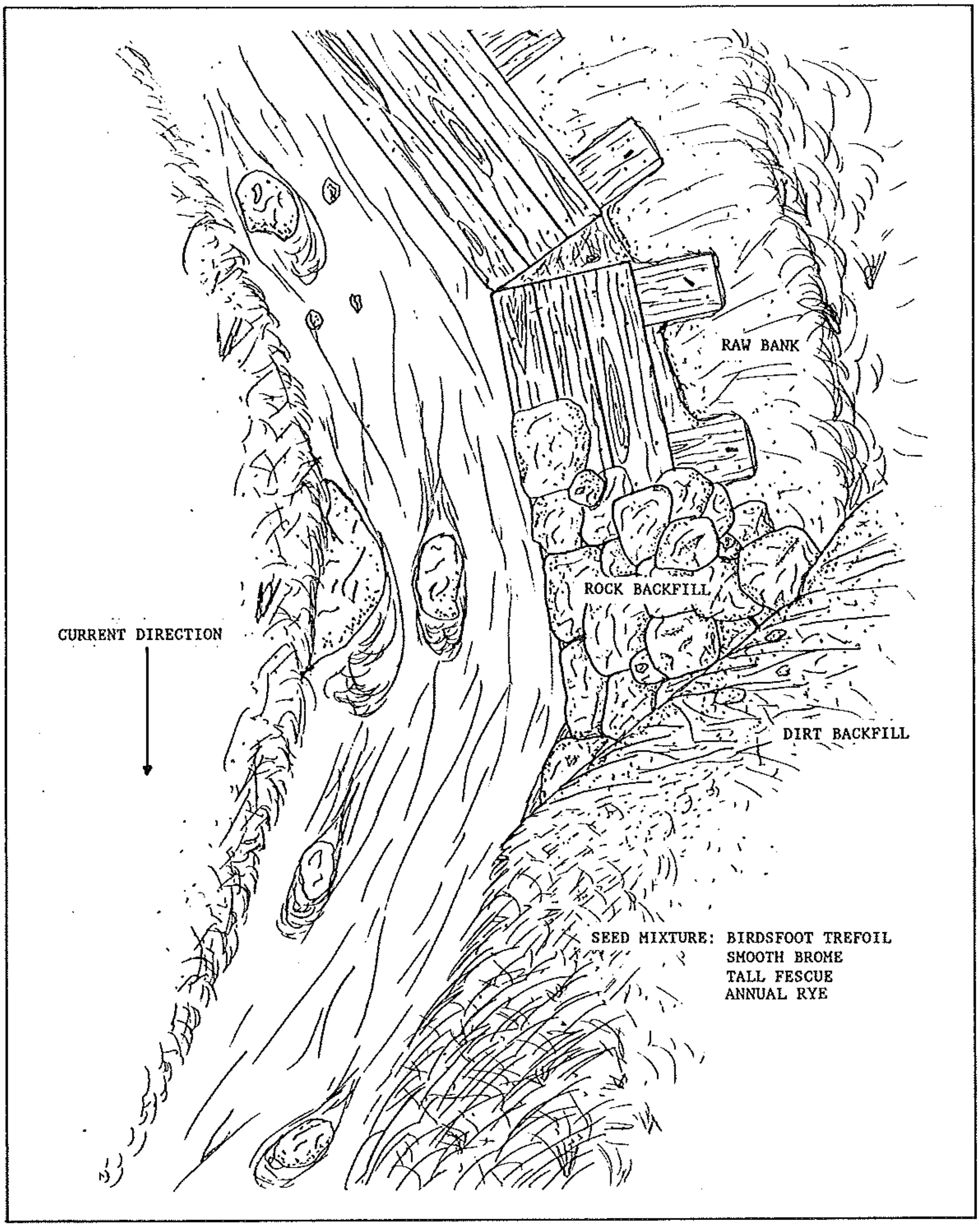


FIGURE 8. Top View, installed LUNKERS unit.

Once site evaluation and access preparations are completed, stockpiling of materials begins. The necessary materials and tools are listed below.

Materials List for a LUNKERS Unit

Lumber: 9 boards (2 inches by 10 inches by 96 inches)
Grass seed: birdsfoot trefoil, smooth brome, tall fescue
Reinforcing rod: nine 5-ft lengths, 5/8-inch diameter
Nails: approximately 60 (20D common)
Blocks: 6 oak blocks, 6-8 inches in diameter by 6-8 inches high
Rock: 8-10 yd^3 pit run riprap

LUNKERS Unit Tool List

- Crawler-loader (1 5/8-yd^3 bucket with backhoe)
- Electric drill
- Gas generator (110 v)
- 5/8-inch auger bit
- Hammers
- Maul
- Rakes
- Shovels
- Tape measure
- Chain saw
- Log chains
- Long pry bar

Rock is hauled when the ground is either frozen or dry, in order to prevent unnecessary damage to pastures and crops. When loading rock from the quarries, care is taken to keep small rocks and gravel (known as "fines") to a minimum. Pit run riprap rock with an average diameter of 24-30 inches is used.

Planking and logs are also stockpiled at the job site. If the oak planking is green, it should be stacked to allow air drying, which will prevent premature rotting and soft spots (Figs. 9, 10).

FIGURE 9.

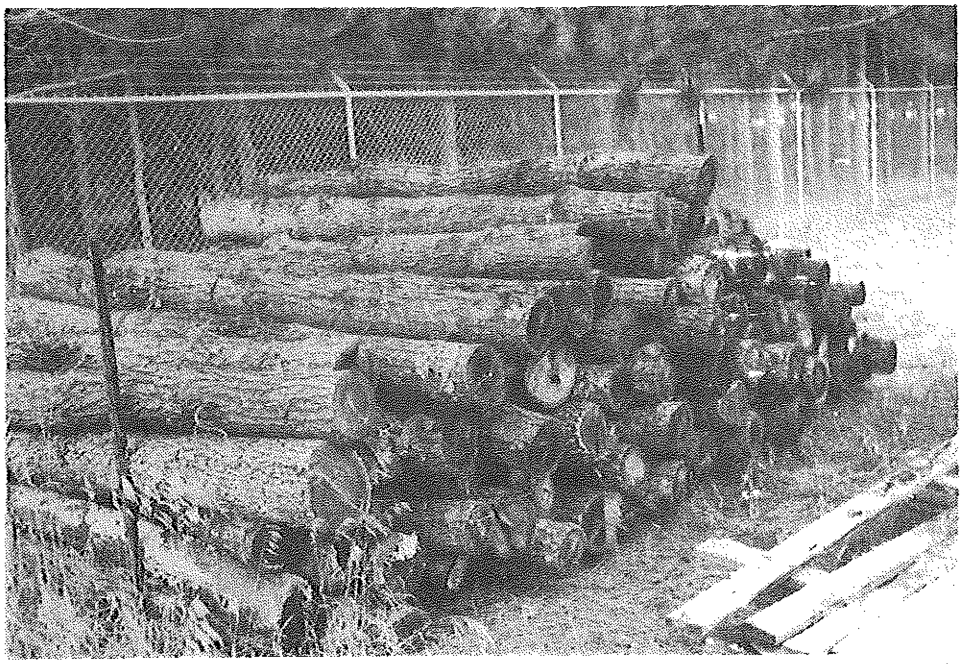


FIGURE 10. Stockpiled oak logs used in the unit construction.

Reinforcing rod comes in 20-ft lengths and must be cut into the 5-ft lengths used in the structures. We use an 8-inch metal-cutting abrasive blade in a circular saw. The rods are cut halfway through and then snapped in two. A cutting torch may be used if care is taken to prevent knobs on the cut ends, which prevent the rods from easily passing through the holes in the planking and blocks.

Once stockpiling of materials is complete, construction of the units can begin.

Construction

Oak blocks are cut in lengths of 6-8 inches with a chain saw, and holes for the reinforcing rod are drilled with a 5/8-inch auger bit. A 6-inch block will allow 10 inches of clearance in the finished structure. All blocks must be cut to the same length for easy assembly. Because of the thickness of the oak blocks, a heavy-duty drill is used. We use a heavy-duty 3/4-inch reversible hole shooter. Enough blocks are cut and drilled to build all the structures for one installation site (Figs. 11, 12). Because the oak blocks have a tendency to spin while being drilled, a holder of some type is helpful (Fig. 13).

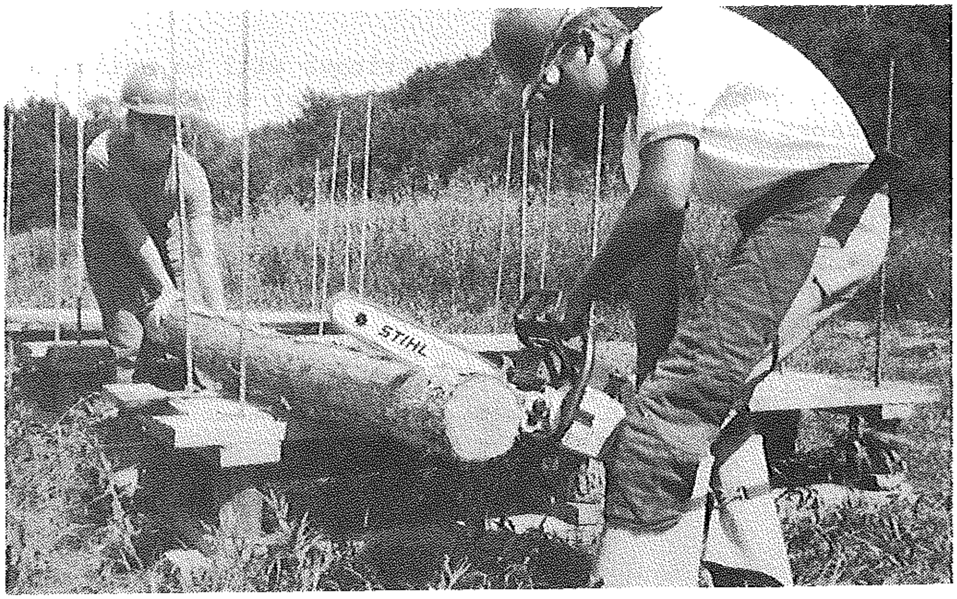


FIGURE 11.

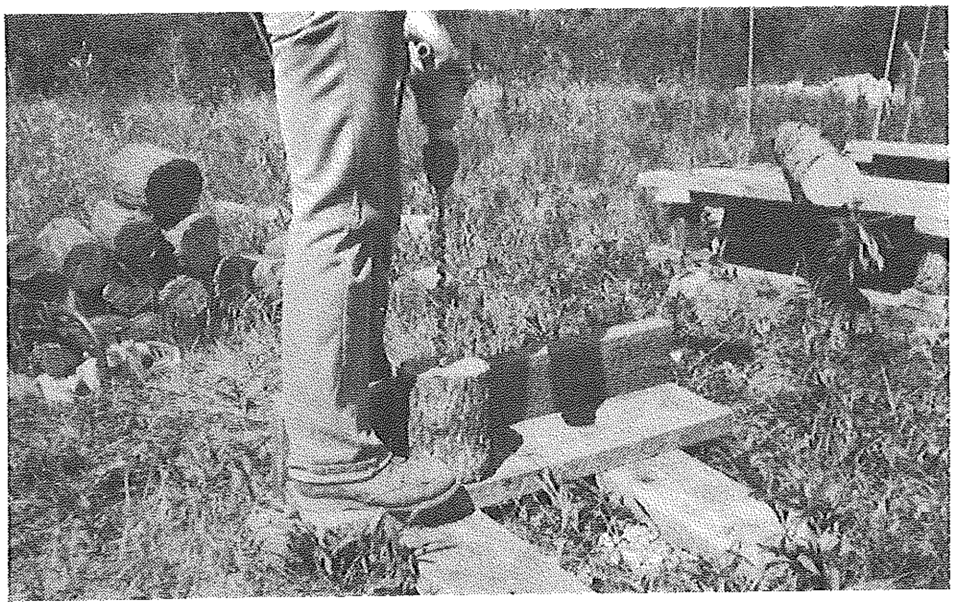


FIGURE 12.

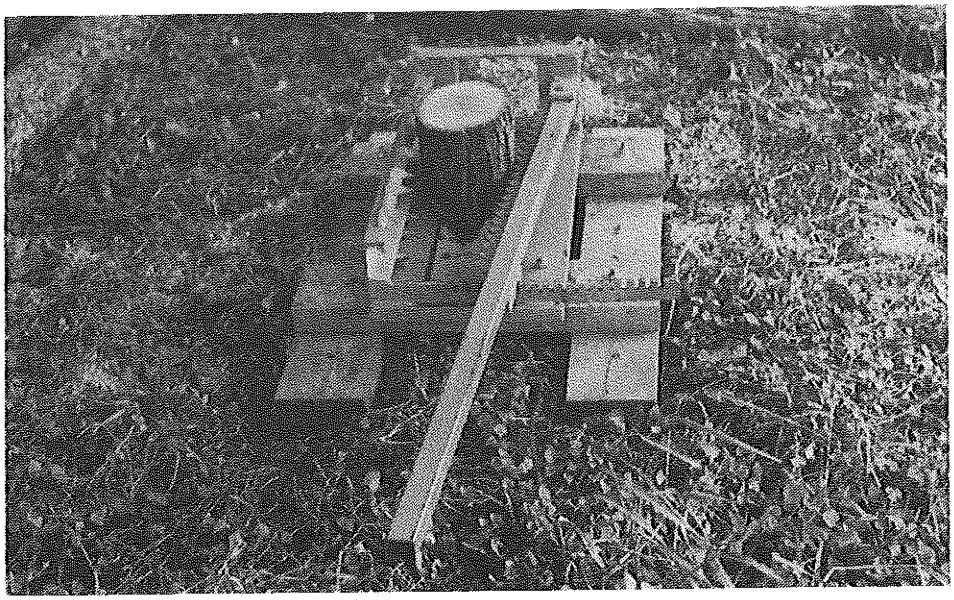


FIGURE 13.

A 2-inch by 10-inch by 48-inch oak plank stringer will be nailed on top of two blocks, and a 2-inch by 10-inch by 30-inch stringer will be nailed to the bottom. Oak planks 2-inches by 10-inches by 96-inches are then nailed to the top and bottom of the stringer boards. This planking is cut and assembled in the same manner as in the completed structure, but the oak blocks are not inserted so that the planks can be drilled. The 5/8-inch auger bit is again used to drill the holes. Scrap lumber placed underneath the planks prevents the drill bit from going into the ground. Once all the holes are drilled, the top planks are removed in a specific order. It is imperative that the structure be assembled in the exact reverse of this order, so all the predrilled holes will line up (Figs. 14, 15).

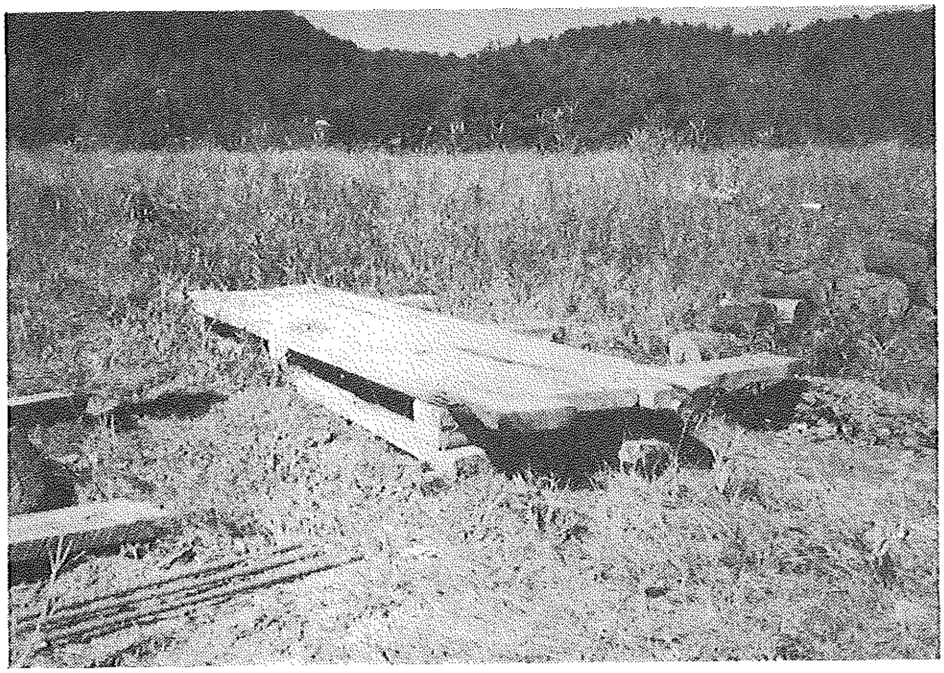


FIGURE 14.

FIGURE 15.

Two lengths of reinforcing rod are pushed through two blocks and a bottom stringer. The bottom stringer is then nailed to the blocks using 20D common nails. This is repeated for the remaining two stringers (Figs. 16, 17).

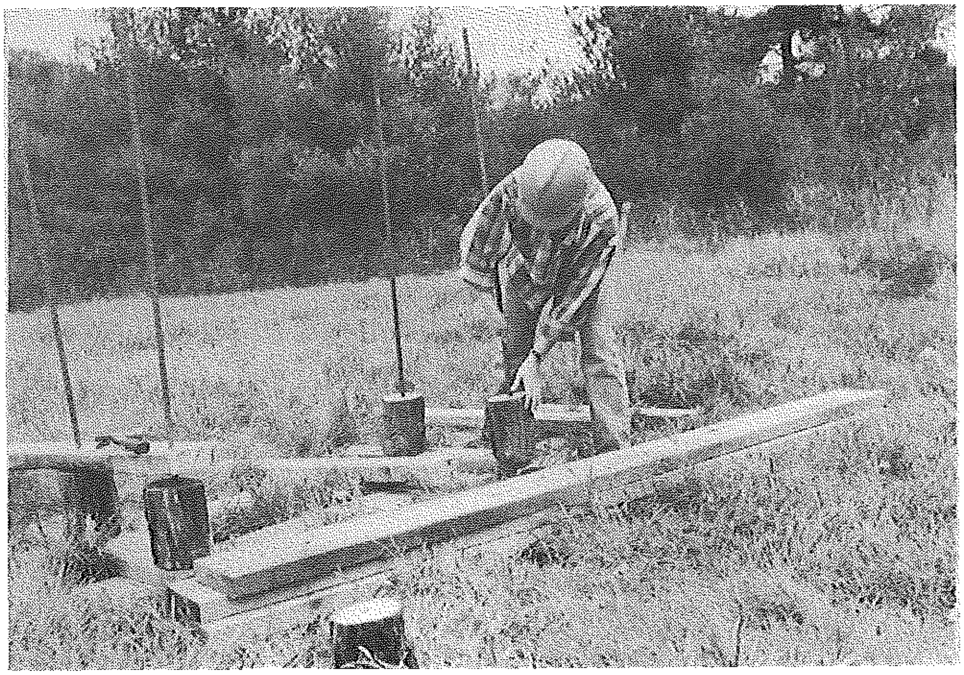


FIGURE 16.

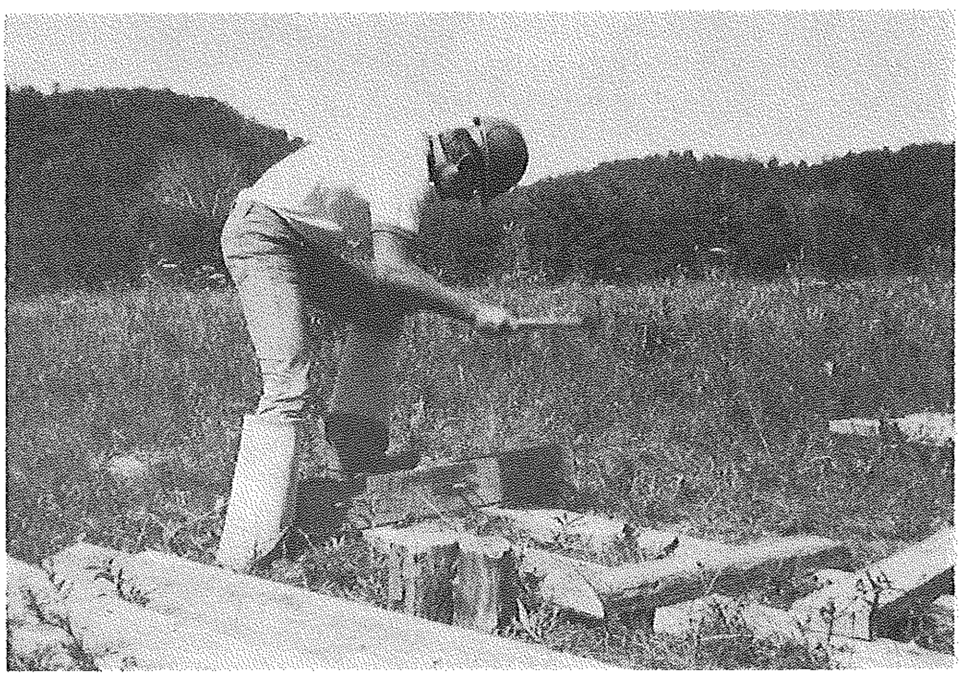


FIGURE 17.

The bottom stringers are placed upright, and a rod is centered through each of the holes in the top stringers. The top stringers are then pushed down to the top of the blocks and nailed (Figs. 18, 19).

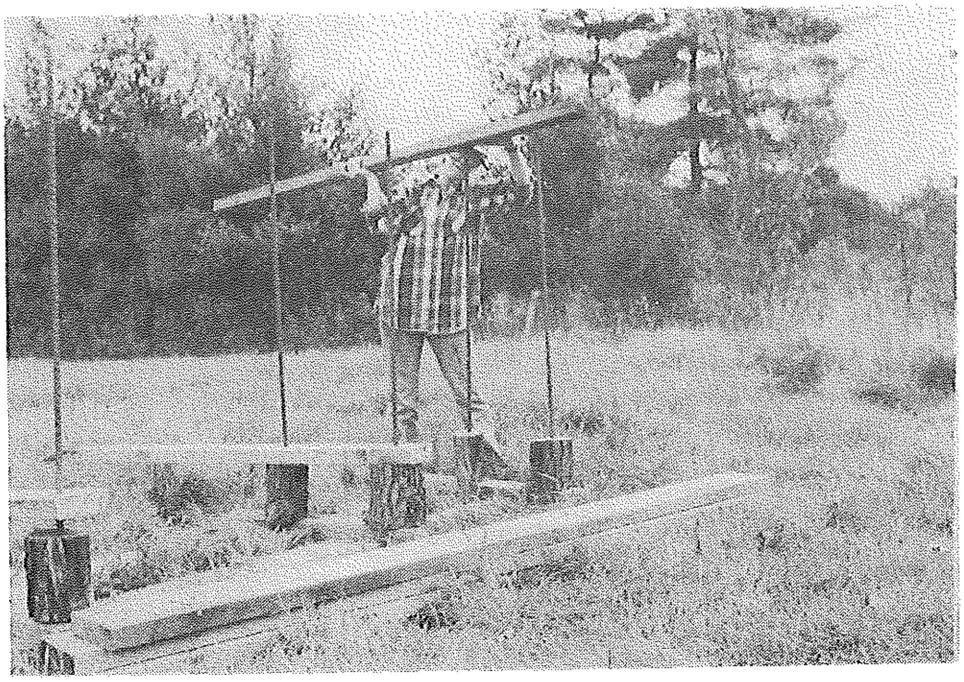


FIGURE 18.

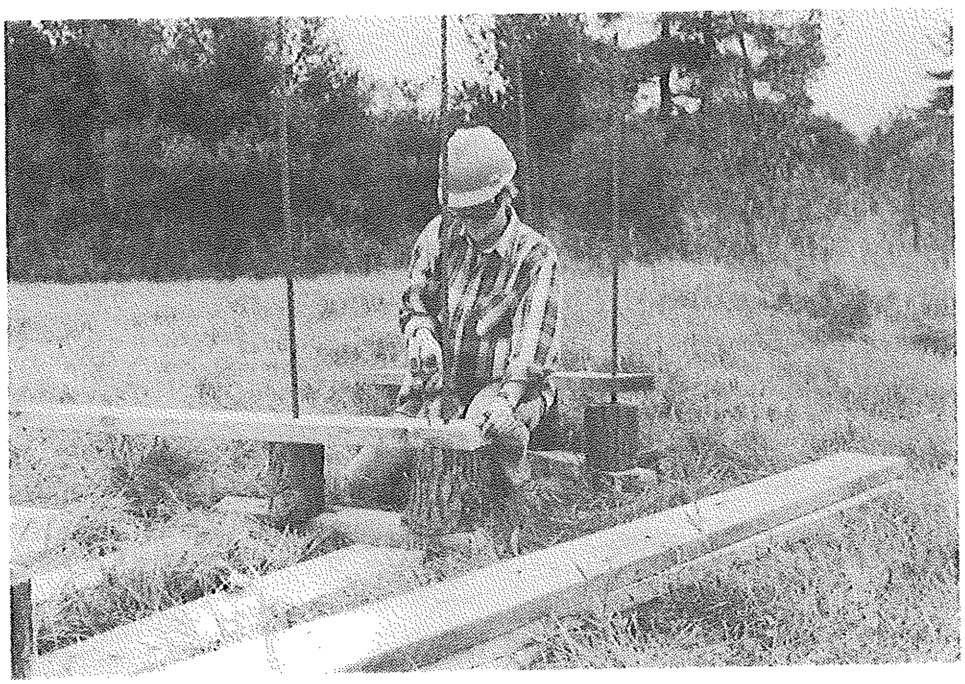


FIGURE 19.

The stringers are placed on the bottom planks, and the rods are driven a few inches through the corresponding holes. The whole structure is then tipped on its front, and the bottom planks are nailed to the bottom stringers (Figs. 20, 21).

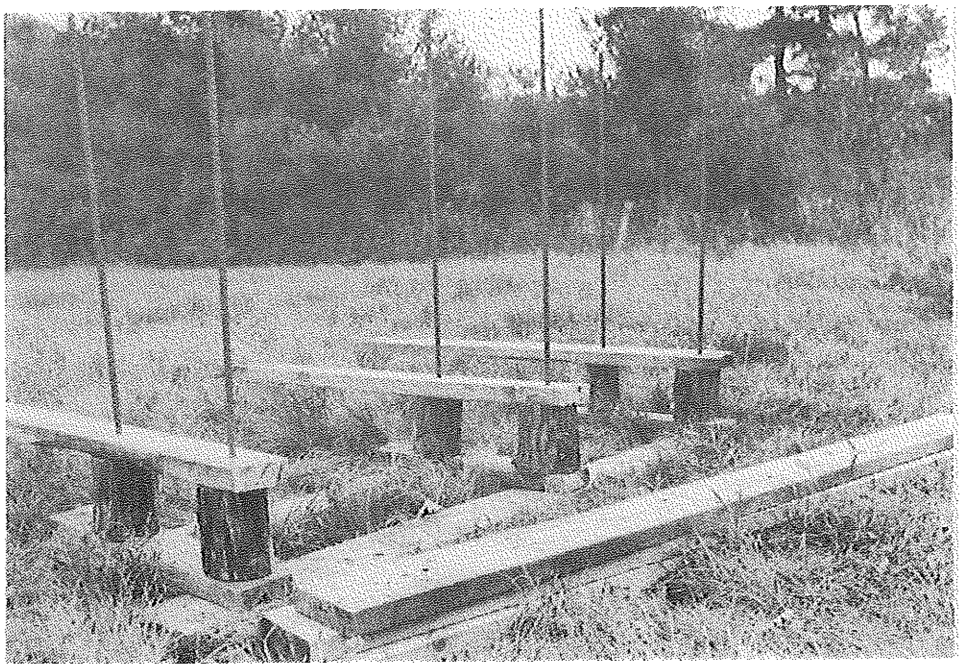


FIGURE 20.

FIGURE 21.

The structure is tipped upright, and the top planks are installed over the rods. The planks are then nailed to the top of the stringers (Figs. 22, 23).

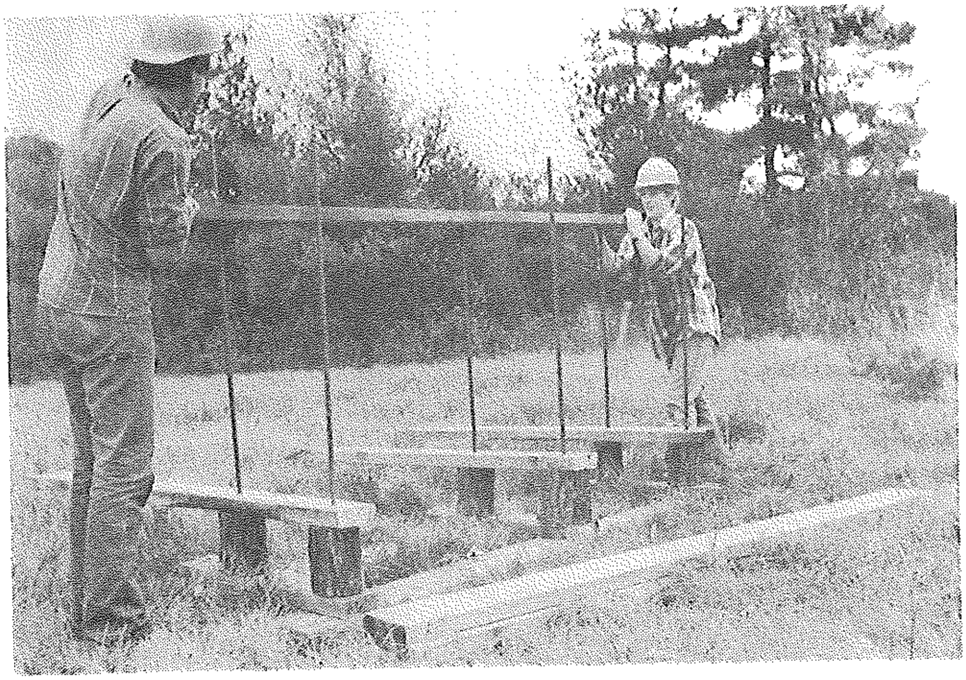


FIGURE 22.

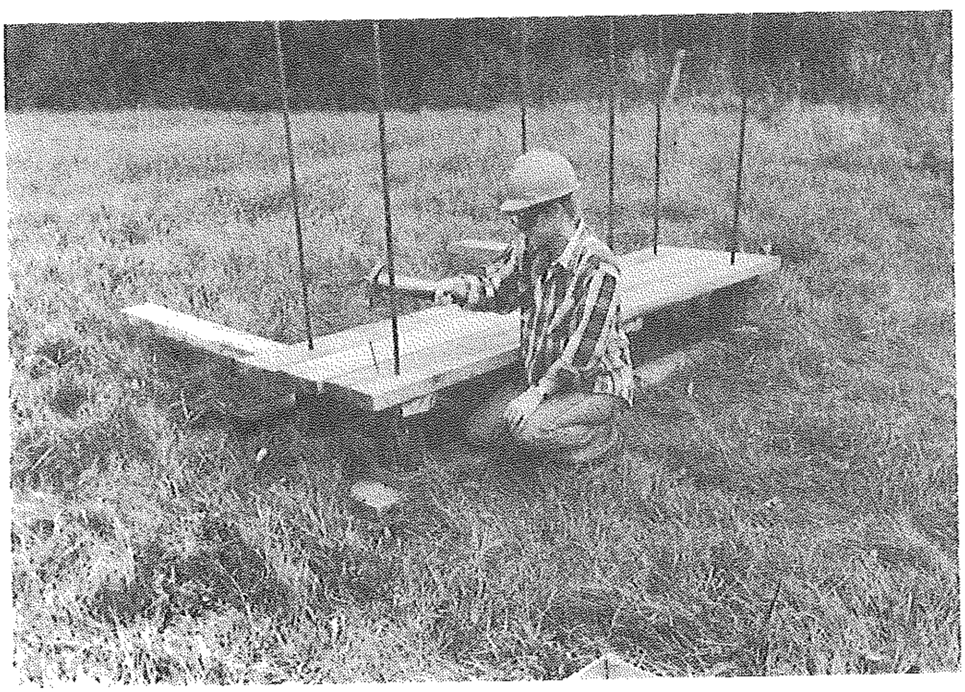


FIGURE 23.

The structure is again tipped on its front, and the backboard is nailed to the rear blocks (Fig. 24). The backboard prevents the rock backfill behind the structure from sloughing into the structure and being eroded by the stream. Nailing the structures together allows for easier installation and will improve longevity. This step completes construction.

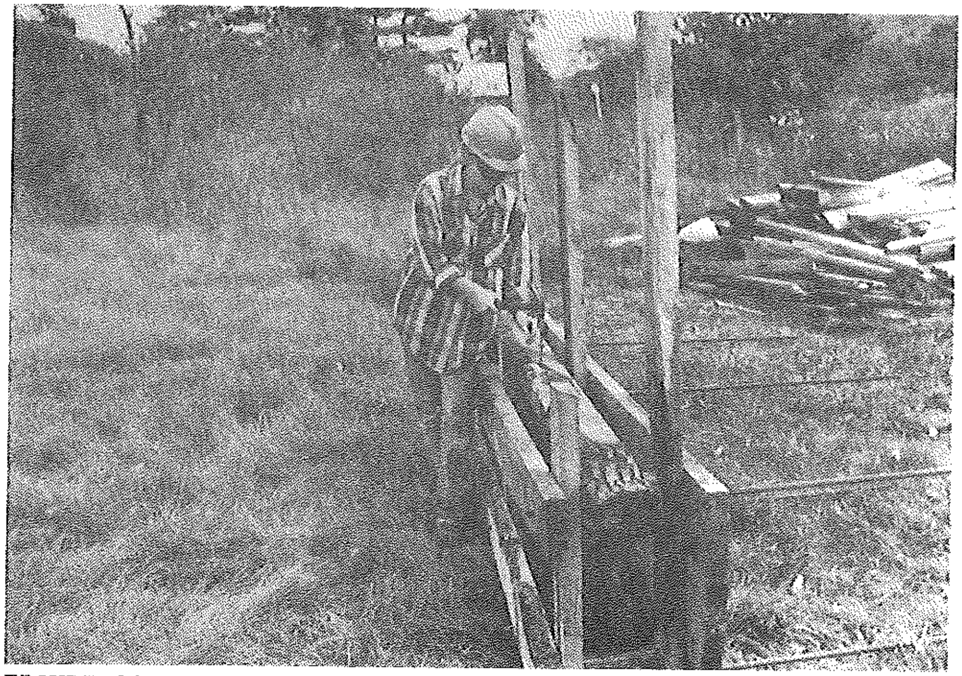


FIGURE 24.

Installation

Most of the La Crosse Area's habitat improvement projects are in pastured, agricultural areas. Brush is therefore not a major problem for structure installation. However, a considerable amount of landscaping is required at sites with high, eroded banks and wide, shallow stream threads. In most cases the stream has to be narrowed to increase velocity and depth and to decrease surface area. For such habitat work, a large crawler-loader (1 5/8-yd^3 bucket) is used. Some regional streams have high banks, but stream width is usually fairly narrow. To achieve adequate sloping in these streams, the use of a large backhoe is recommended to pull back the stream banks. Slopes should not exceed a gradient of 2:1.

Much of the landscaping is completed prior to installation of the structures in the stream. This preparation saves time and allows easier access to the site. Once site preparation is completed, final structure installation can begin. The completed structure is carried to the stream with chains hooked to the bucket of the crawler-loader (Fig. 25).

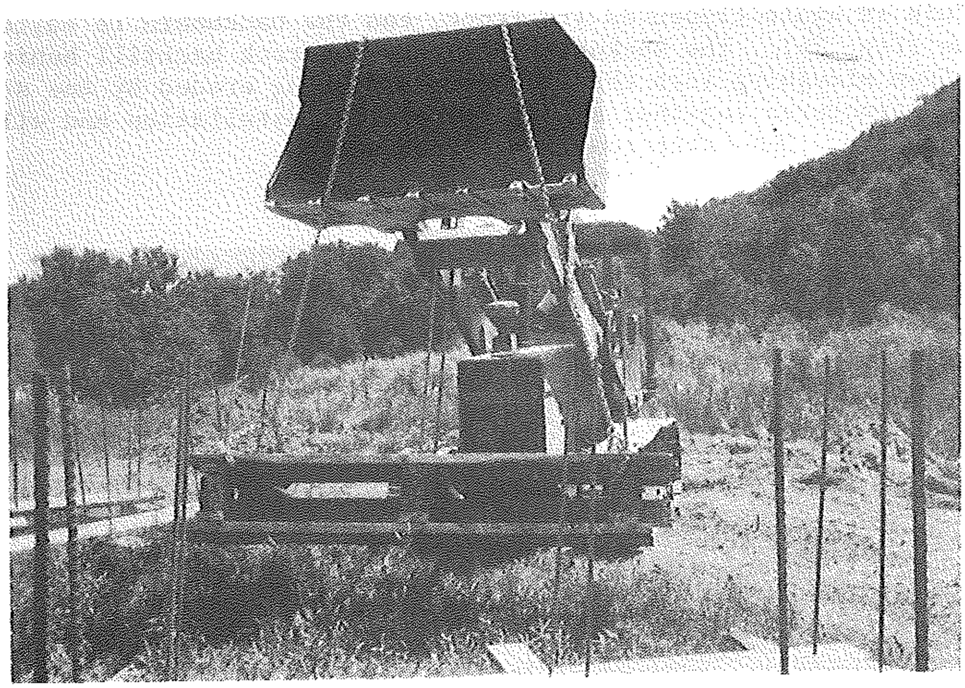


FIGURE 25.

Once the structure is placed in the stream, it can be easily moved into place by two crew members (Fig. 26). The top of the structure should be at least 6 inches below the surface of the water. Care should be taken to keep the structure as level as possible. A level structure will allow easier installation of face rock.

FIGURE 26.

When the structure is in its final location, a maul is used to drive the reinforcing rods into the streambed so the tops of the rods are flush with the tops of the planks (Fig. 27). To drive the rods below the surface of the

FIGURE 27.

water, a driver fashioned from a 2-ft length of 2-inch truck axle inside a thick-walled steel pipe is used. Hollowing out the center of the axle to a depth of 3/4 inch on the bottom end will help keep it on the rod while it is being struck with the maul (Fig. 28).

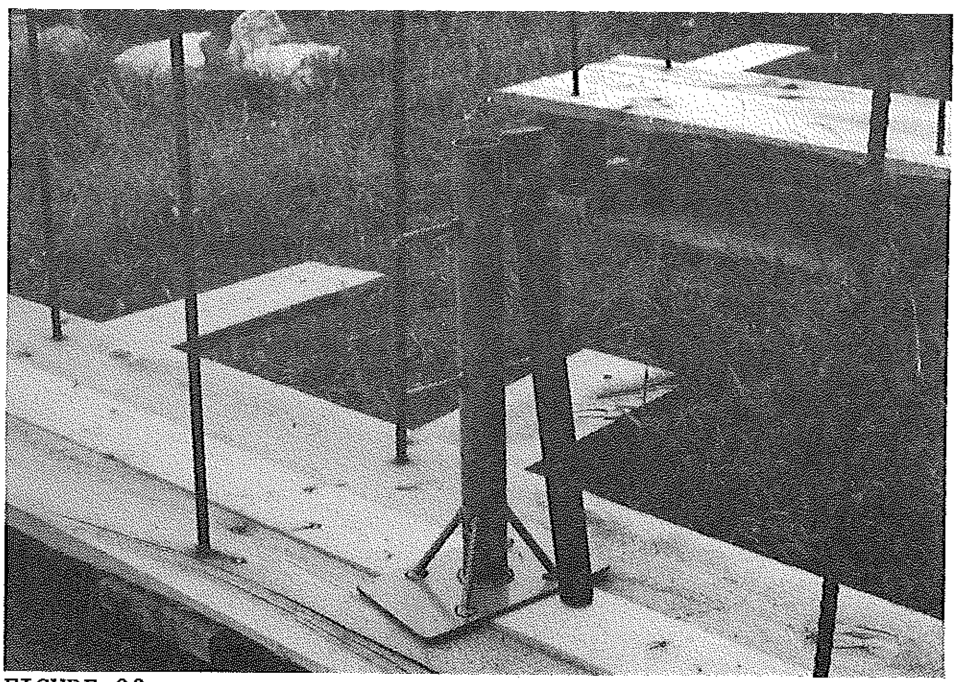


FIGURE 28.

Once all the structures have been installed, the placement of the face rock begins. When angular rocks are available, large rocks with flat bottoms and faces can be positioned on the structures using a chain hooked to the bucket of the crawler-loader and large pry bars. The front face of the rock should be flush with the front edge of the top plank (Fig. 29).

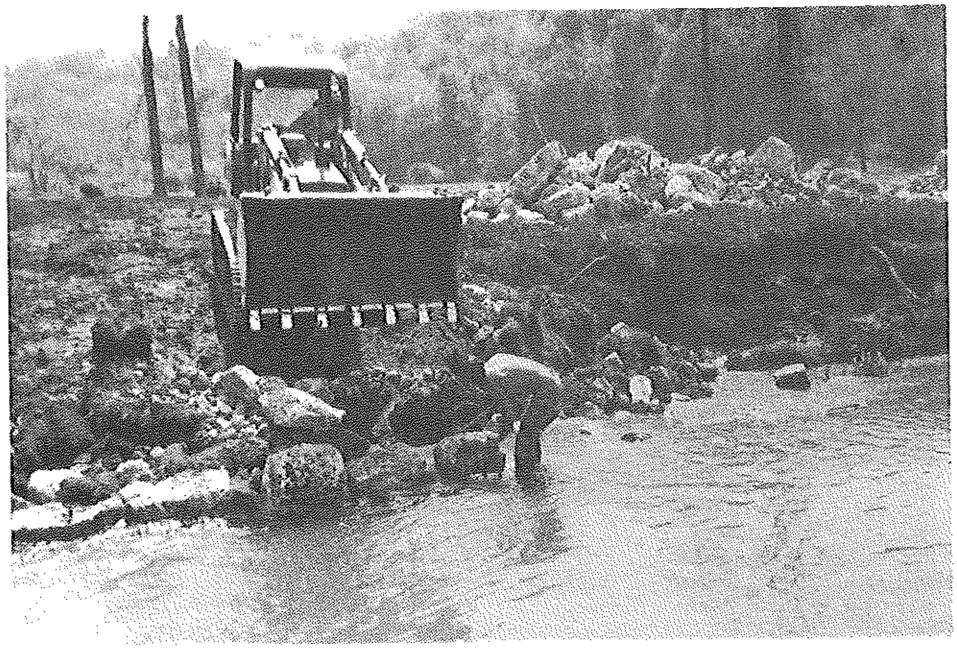


FIGURE 29.

After all the face rocks have been installed, the structures are backfilled with additional rock. If enough rock is available, it should be installed to the level of the normal high water mark. Large rocks should also be placed upstream and downstream of the structures to form a continuous line of rock around the outside bend of the stream bank (Figs. 30, 31).

FIGURE 30.

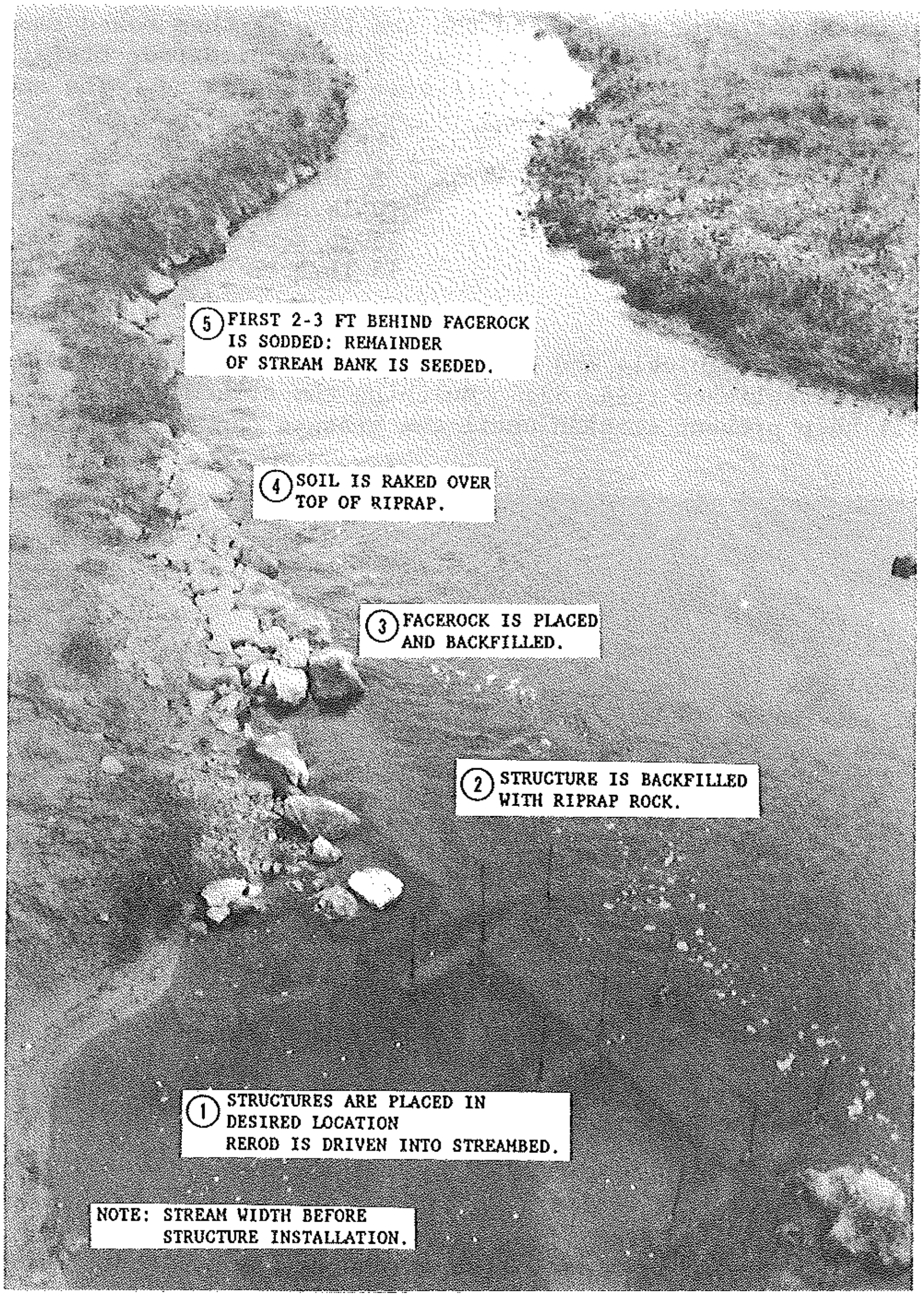


FIGURE 31. Steps in LUNKERS unit construction.

Soil is bulldozed and raked over the top of the rocks right to the edge of the face rocks. Sod scraped from the stream bank is placed along the outer 2-3 ft of structure. This will prevent erosion of soil and seed until the seed becomes established. The area behind the sod line is then raked smooth and seeded with a mixture of smooth brome, tall fescue, birdsfoot trefoil, and annual rye grass. The birdsfoot trefoil must be inoculated. The amount of seed used is as follows:

Birdsfoot trefoil	5 lb/acre
Smooth brome	10 lb/acre
Tall fescue	15 lb/acre
Annual rye	15 lb/acre

Annual rye germinates quickly and will help protect the other seeds until they become firmly established (Fig. 32). Mulching the stream bank with straw or old hay will help prevent erosion until the grasses can take hold.

FIGURE 32.

In 1987 a "mini" version of the LUNKERS structure was built for use in small streams with an average width of 3-5 ft. These structures create 12-18 inches of overhang instead of the 24-30 inches created by the full-sized LUNKERS. The same materials are used for construction. Six 5/8-inch reinforcing rods cut to 4-ft lengths anchor these mini-structures. Installation in the streambed and final landscaping are the same as for the full-sized LUNKERS structure (Figs. 33, 34).

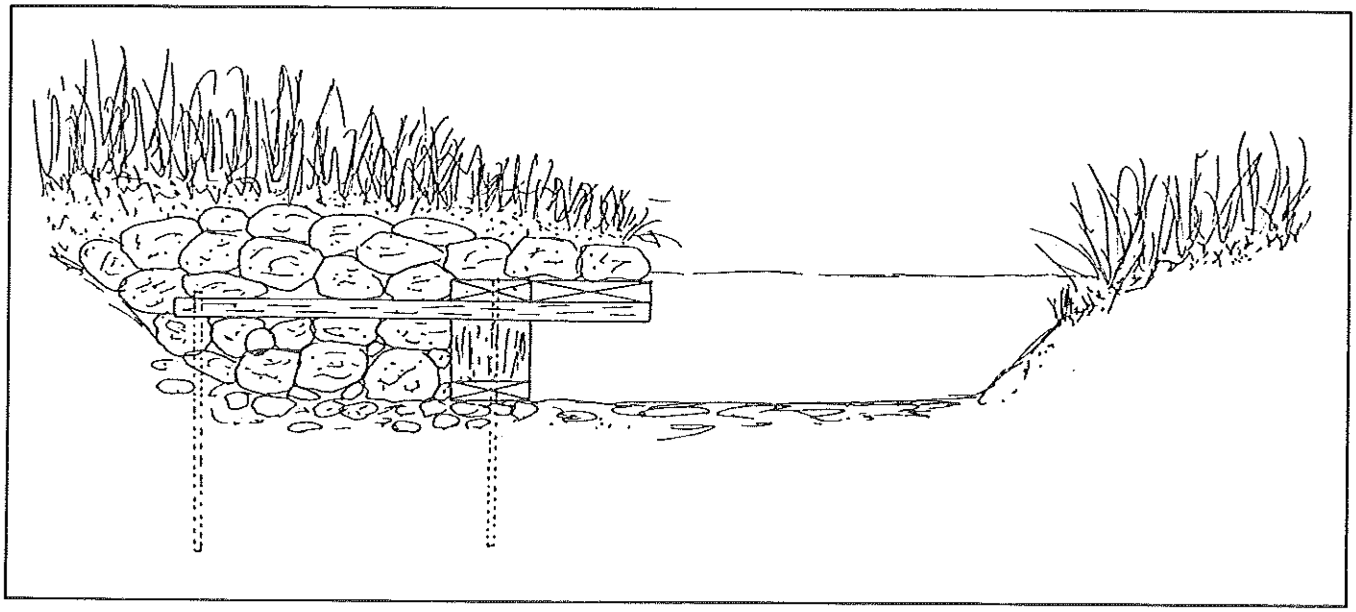


FIGURE 33. Side view, installed MINI-LUNKERS unit for use in small streams.

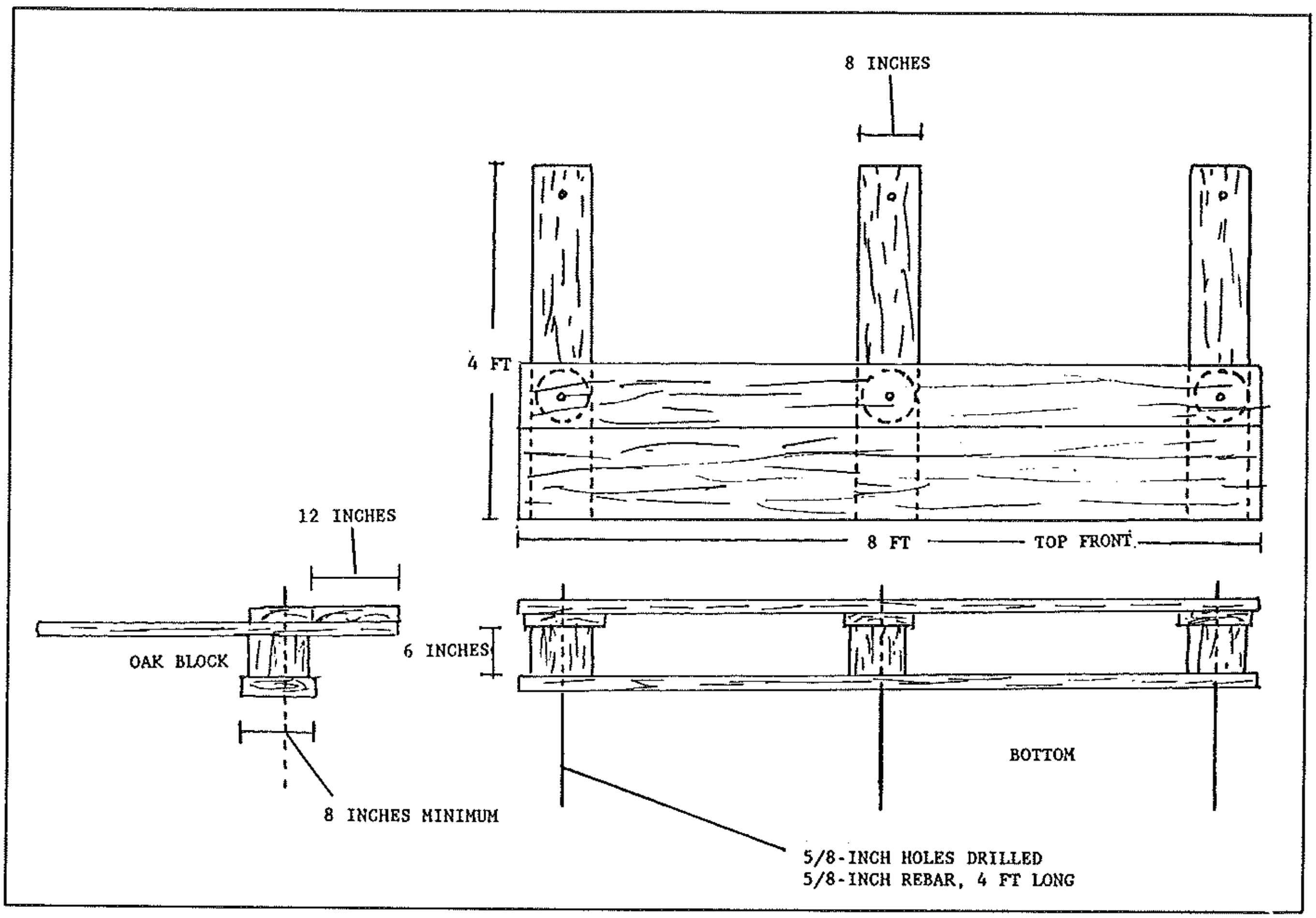
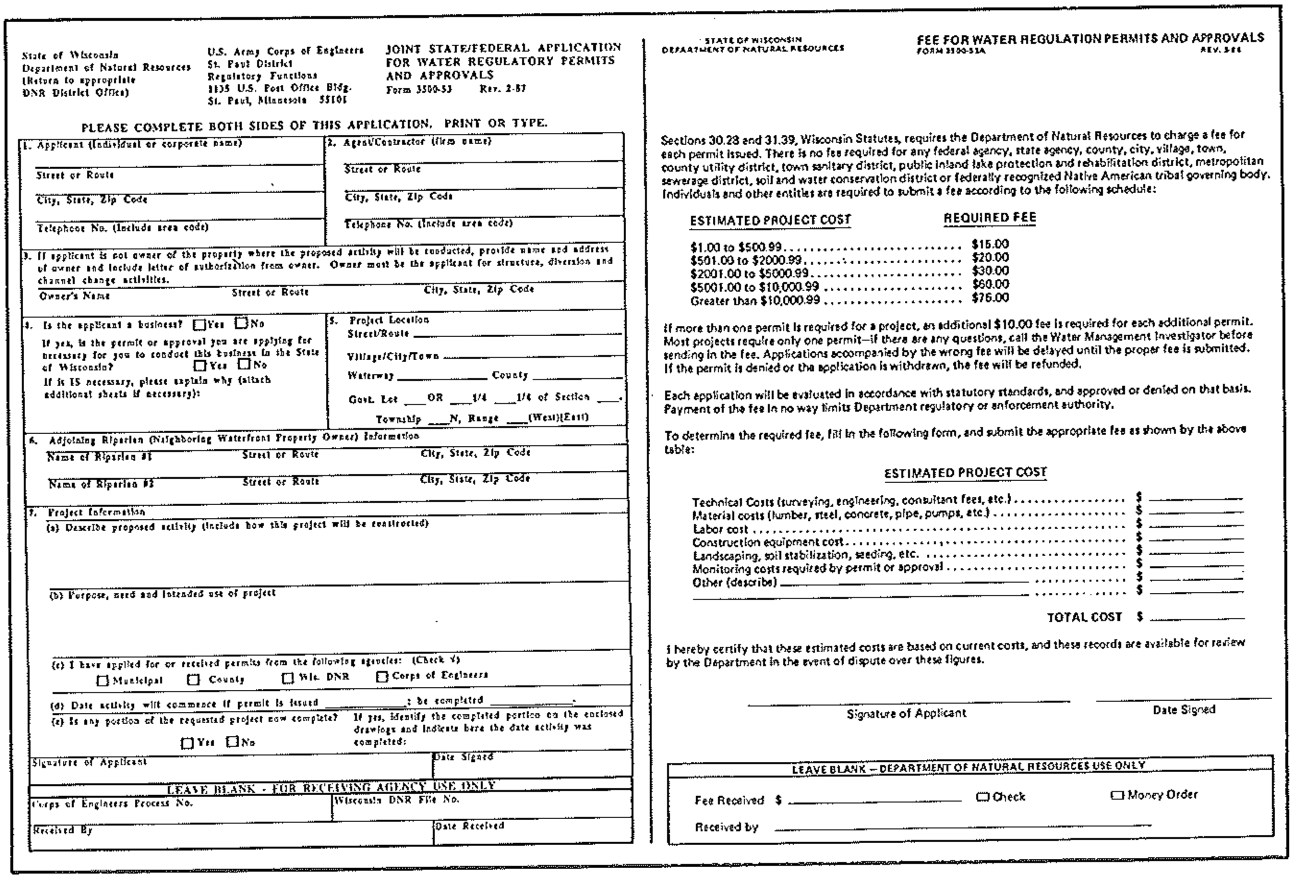


FIGURE 34.

PERMITS

In many states some type of permit is required before any development can be initiated in lakes or streams. In Wisconsin there are several steps that must be completed prior to starting a habitat improvement project.

Form 3500-53, Joint State/Federal Application for Water Regulatory Permit and Approval, must be submitted to the water management specialist in the appropriate DNR Area office. If the applicant is other than a federal, state, or local government agency, there is a required fee based on estimated project costs. In this case, form 3500-53A must be submitted with the application form (Fig. 35). Both forms and assistance are available at any Wisconsin DNR office.



State of Wisconsin
Department of Natural Resources
(Return to appropriate DNR District Office)

U.S. Army Corps of Engineers
St. Paul District
Regulatory Functions
1135 U.S. Post Office Bldg.
St. Paul, Minnesota 55101

JOINT STATE/FEDERAL APPLICATION FOR WATER REGULATORY PERMITS AND APPROVALS
Form 3500-53 Rev. 2-87

PLEASE COMPLETE BOTH SIDES OF THIS APPLICATION. PRINT OR TYPE.

1. Applicant (Individual or corporate name)
Street or Route
City, State, Zip Code
Telephone No. (Include area code)

2. Agent/Contractor (firm name)
Street or Route
City, State, Zip Code
Telephone No. (Include area code)

3. If applicant is not owner of the property where the proposed activity will be conducted, provide name and address of owner and include letter of authorization from owner. Owner must be the applicant for structure, diversion and channel change activities.
Owner's Name Street or Route City, State, Zip Code

4. Is the applicant a business? ☐ Yes ☐ No
If yes, is the permit or approval you are applying for necessary for you to conduct this business in the State of Wisconsin? ☐ Yes ☐ No
If it IS necessary, please explain why (attach additional sheets if necessary):

5. Project Location
Street/Route ______
Village/City/Town ______
Waterway ______ County ______
Govt. Lot ___ OR ___1/4 ___1/4 of Section ___.
Township ___N, Range ___(West)(East)

6. Adjoining Riparian (Neighboring Waterfront Property Owner) Information
Name of Riparian #1 Street or Route City, State, Zip Code
Name of Riparian #2 Street or Route City, State, Zip Code

7. Project Information
(a) Describe proposed activity (include how this project will be constructed)
(b) Purpose, need and intended use of project
(c) I have applied for or received permits from the following agencies: (Check ✓)
☐ Municipal ☐ County ☐ Wis. DNR ☐ Corps of Engineers
(d) Date activity will commence if permit is issued ______; be completed ______.
(e) Is any portion of the requested project now complete? ☐ Yes ☐ No
If yes, identify the completed portion on the enclosed drawings and indicate here the date activity was completed:

Signature of Applicant Date Signed

LEAVE BLANK - FOR RECEIVING AGENCY USE ONLY
Corps of Engineers Process No. Wisconsin DNR File No.
Received By Date Received

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES

FEE FOR WATER REGULATION PERMITS AND APPROVALS
FORM 3500-53A REV. 5-86

Sections 30.28 and 31.39, Wisconsin Statutes, requires the Department of Natural Resources to charge a fee for each permit issued. There is no fee required for any federal agency, state agency, county, city, village, town, county utility district, town sanitary district, public inland lake protection and rehabilitation district, metropolitan sewerage district, soil and water conservation district or federally recognized Native American tribal governing body. Individuals and other entities are required to submit a fee according to the following schedule:

ESTIMATED PROJECT COST	REQUIRED FEE
\$1.00 to \$500.99	\$15.00
\$501.00 to \$2000.99	\$20.00
\$2001.00 to \$5000.99	\$30.00
\$5001.00 to \$10,000.99	\$60.00
Greater than \$10,000.99	\$75.00

If more than one permit is required for a project, an additional \$10.00 fee is required for each additional permit. Most projects require only one permit—if there are any questions, call the Water Management Investigator before sending in the fee. Applications accompanied by the wrong fee will be delayed until the proper fee is submitted. If the permit is denied or the application is withdrawn, the fee will be refunded.

Each application will be evaluated in accordance with statutory standards, and approved or denied on that basis. Payment of the fee in no way limits Department regulatory or enforcement authority.

To determine the required fee, fill in the following form, and submit the appropriate fee as shown by the above table:

ESTIMATED PROJECT COST

Technical Costs (surveying, engineering, consultant fees, etc.) .... \$ ______
Material costs (lumber, steel, concrete, pipe, pumps, etc.) .... \$ ______
Labor cost .... \$ ______
Construction equipment cost .... \$ ______
Landscaping, soil stabilization, seeding, etc. .... \$ ______
Monitoring costs required by permit or approval .... \$ ______
Other (describe) ______ .... \$ ______
______ .... \$ ______

TOTAL COST \$ ______

I hereby certify that these estimated costs are based on current costs, and these records are available for review by the Department in the event of dispute over these figures.

Signature of Applicant Date Signed

LEAVE BLANK — DEPARTMENT OF NATURAL RESOURCES USE ONLY
Fee Received \$ ______ ☐ Check ☐ Money Order
Received by ______

FIGURE 35. Forms 3500-53 and 3500-53A.

The water management specialist then submits a copy of the permit application to the U.S. Army Corps of Engineers. In some cases the Corps of Engineers will issue their own permits for certain navigable waters of the state. The county zoning administrator should also be contacted to determine if any permits are required to satisfy local zoning ordinances.

After the permit application has been submitted to DNR, the water management specialist checks the site for environmental impacts, type of vegetation, bottom type, water depth, etc., and gets the necessary approvals from within DNR. Because it may take 2-4 months to complete this process, the applicant should file early. No habitat work can start before the necessary permits are issued.

At some point during DNR's review process, a public notice must be published in the local newspaper to determine if a public hearing is needed. Publishing cost for the public notice must be paid by the applicant. If no one objects to the development or requests a hearing, a permit to start the project is issued.

COMPARATIVE HABITAT IMPROVEMENT COSTS

As stated earlier, unit costs for the log wing deflectors were approximately $419.00 in 1980, as itemized below. If these figures are inflated to 1988 costs, each structure would cost $544.00, an increase of 23%. The majority of this increase would be due to the higher cost of transporting materials and higher labor costs.

1980 Per-unit Cost Estimate for Log Wing Deflectors

Rock: 20 yd^3 @ $7.00 yd^3 delivered	$140.00
Steel fence posts: 2 @ $2.30	4.60
Logs: 10 @ $1.95	19.50
Nails and staples: $1.00/structure	1.00
Hog wire: 20 ft @ $.25/ft	5.00
Brace wire: 10 ft @ $.06/ft	.60
Seed: 1/4 lb @ $2.00/lb	.50
Tractor (3/4-yd^3 bucket): 1 hour @ $3.00/hour	3.00
MF 200 Cat.: 8 hours @ $385.00/week	80.00
100 FW HP tractor: 4 hours @ $6.25/hour	25.00
Backhoe: 1/2 hour @ $385.00/week	40.00
Labor: 20 hours @ $5.00/hour	100.00
Total	$419.20

The LUNKERS units, by contrast, each cost about $297.00, as itemized below. This cost represents a saving of 30% over the 1980 cost of the log wing deflector, and a 46% saving over the projected 1988 cost.

The bulk of these savings result from reduced labor hours per unit and reduced material costs through the use of local planking rather than logs hauled 50-60 miles.

1988 Per-unit Cost Estimates for La Crosse LUNKERS Units

Rock: 20 yd^3 @ $8.00 yd^3 delivered		$160.00
Reinforcing rod: 45 ft @ $.18/ft		8.10
Planking: 75 board ft @ $.20/board ft		15.00
Nails (20D common): 2.63 lb @ $.60/lb		1.57
Oak blocks: 6 blocks @ $.25 ea.		1.50
Seed: 3.5 lb @ $1.20/lb		4.20
Equipment rental: 4 hours @ $9.87/hour		39.48
Diesel fuel: 5 gal @ $.90/gal		4.50
Labor: 10 hours @ $6.31/hour		63.10
	Total	$297.45

Given the ease with which the LUNKERS unit can be constructed and installed, private conservation groups, rod and gun clubs, and similar organizations can initiate habitat improvement projects on their own. Labor and materials that may be donated by these organizations would decrease the cost per unit. In 1986 the 24 Valley Trout Club installed 33 LUNKERS structures in 24 Valley Creek, Vernon County. The club built the structures on the stream bank and contracted the in-stream installation to a local vendor. The unit cost was $209.00 including landscaping and seeding.

Construction and installation costs vary for different streams, depending on several factors: the distance riprap rock has to be hauled, the degree of erosion of stream banks, and the amount of landscaping required. In 1985 and 1986, Spring Coulee and Timber Coulee creeks were developed under the Trout Stamp Program. The cost per mile for each stream was a reflection of the above mentioned parameters.

Spring Coulee had a predevelopment width of approximately 13 ft. Because this width was not excessive, most of the landscaping involved pulling the bank back to achieve a desirable slope. Less severely eroded outside bends required less material for structure installation. The quarry utilized for riprap rock was approximately 2.5 miles away. Development cost for Spring Coulee was approximately $25,000/mile of stream thread.

Two sections of Timber Coulee were developed in 1985-86. In 1985 the upper portion was completed. The average stream width in this section was approximately 18 ft before development. This area had severely eroded banks and required considerably more landscaping than Spring Coulee. Some rock was obtained from a local landowner, while the rest had to be hauled 12 miles from the quarry. Cost for habitat work in this section of Timber Coulee was approximately $34,000/mile.

In 1986 a section on the lower end of Timber Coulee was developed. Average stream width was 29 ft, and some eroded banks were in excess of 12 ft in height. This was by far the widest stream section ever improved in the La Crosse Area. Costs for development were increased by the large amounts of landscaping and materials required for the project. Although the quarry is only 7 miles from the project area, rock had to be hauled 16 miles, since the weight limit for a nearby bridge scheduled for replacement was lowered to 6 tons. The development cost for this stretch of stream was approximately $41,000/mile.

DISCUSSION

Advantages of the LUNKERS Structure

The geology and geography of the coulee region provide all the basic requirements for excellent trout production. Abundant springs provide consistent base flows and stable water temperatures. Limestone bedrock provides nutrients, and the relief of the coulee region includes stream gradients that ensure adequate current velocities. Unfortunately this same relief encourages severe flash flooding during heavy rains. Flooding, coupled with poor land use, has prevented many streams from approaching their optimum trout carrying capacity. Flood retention dams have reduced flooding on many area streams. Improved land use on some streams has allowed trout production to naturally increase to high levels, but past damage has left many streams with little or no overhead cover, steeply eroded stream banks, and silt-covered stream bottoms.

The log wing deflectors used prior to 1982 helped stabilize area streams and improved overhead cover for trout. But because of the high loss rate for these structures during high water, there were periodic setbacks to stream stability and subsequent decreases in trout numbers. These problems were successfully addressed with the introduction of the LUNKERS structure.

The old log structures had only 4 anchor points per 10-15 ft length--2 fence posts in the streambed and 2 anchor logs in the stream bank. The new plank structures have 12 anchor points per 8-ft length--9 reinforcing rods in the streambed and 3 stringers in the stream bank. These additional anchor points, along with rocking and sloping of the banks, make LUNKERS structures much more stable than log wing deflectors during high-water periods. The fact that the new structures can be installed below the water surface also contributes to increased stability.

In 1983 Spring Coulee Creek in Vernon County received the first prototype LUNKERS structures. In June 1984, the stream was subjected to a 500-year flash flood. Normal flow at Spring Coulee is about 2,900 gal/min. During this flash flood, discharge reached an estimated 5.4 <u>million</u> gal/min flow. Inspection of the stream after the event showed damage restricted to a few displaced rocks and the loss of topsoil from the structures. It was obvious then that LUNKERS structures are an affordable yet effective means of implementing habitat improvement projects in the coulee region.

Because the current flows through the LUNKERS structure, no silting occurs at the lower end, even in multi-structures that total 60 ft or more in length. The oak spacers also block the current enough to provide several resting places for trout in each structure.

After installation of LUNKERS structures, streams that once had severe erosion, silted stream beds, and overly wide channels were virtually unrecognizable only a year after development (Figs. 36, 37). Streams that have had a major segment improved show the benefits of an intensive habitat development program. Reduction of silt as a result of stabilized stream banks, decreased surface area, increased depth and current velocity, and

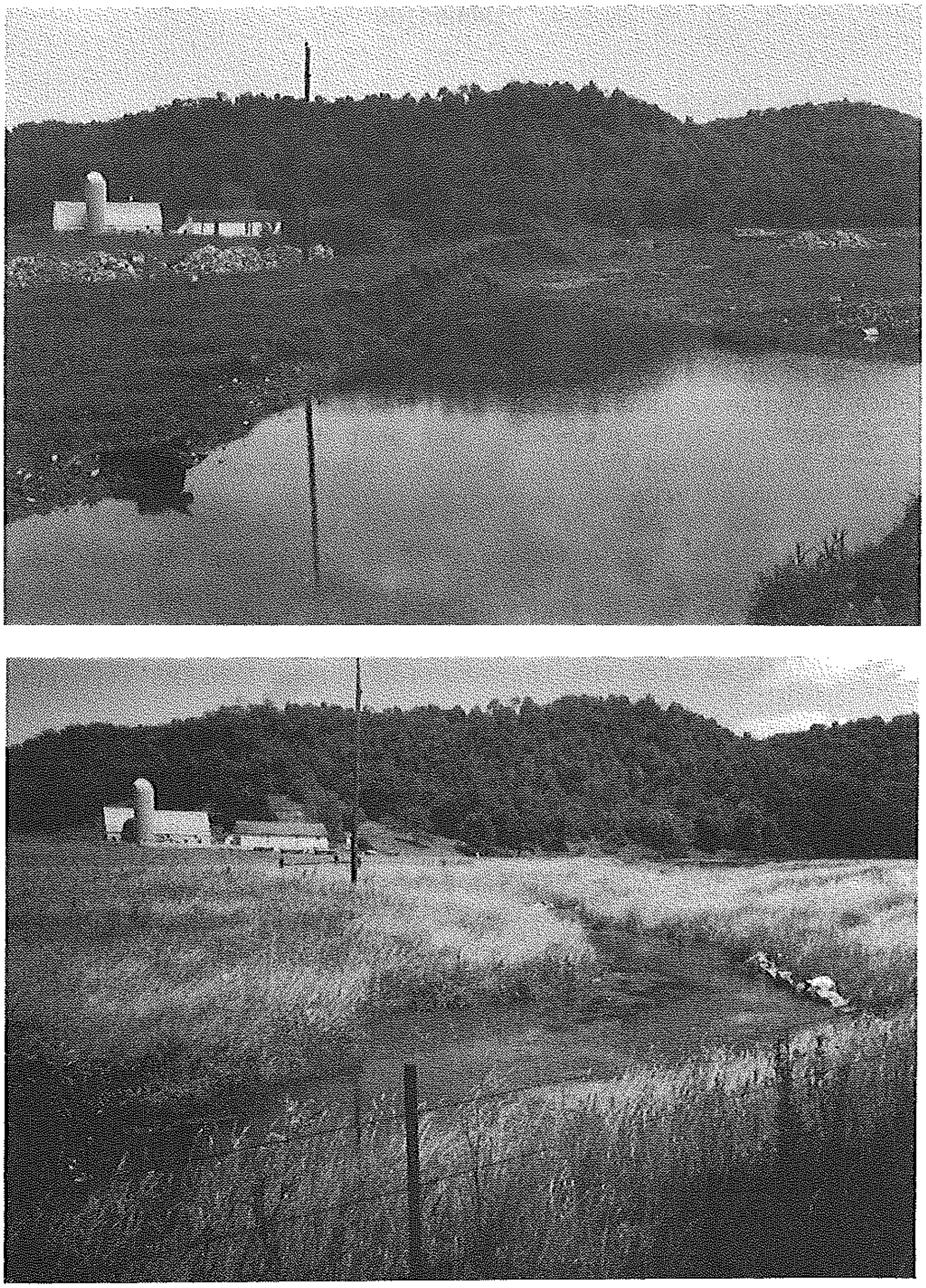


FIGURE 36. Before and after habitat improvement, Timber Coulee, Vernon County, 1985-86.

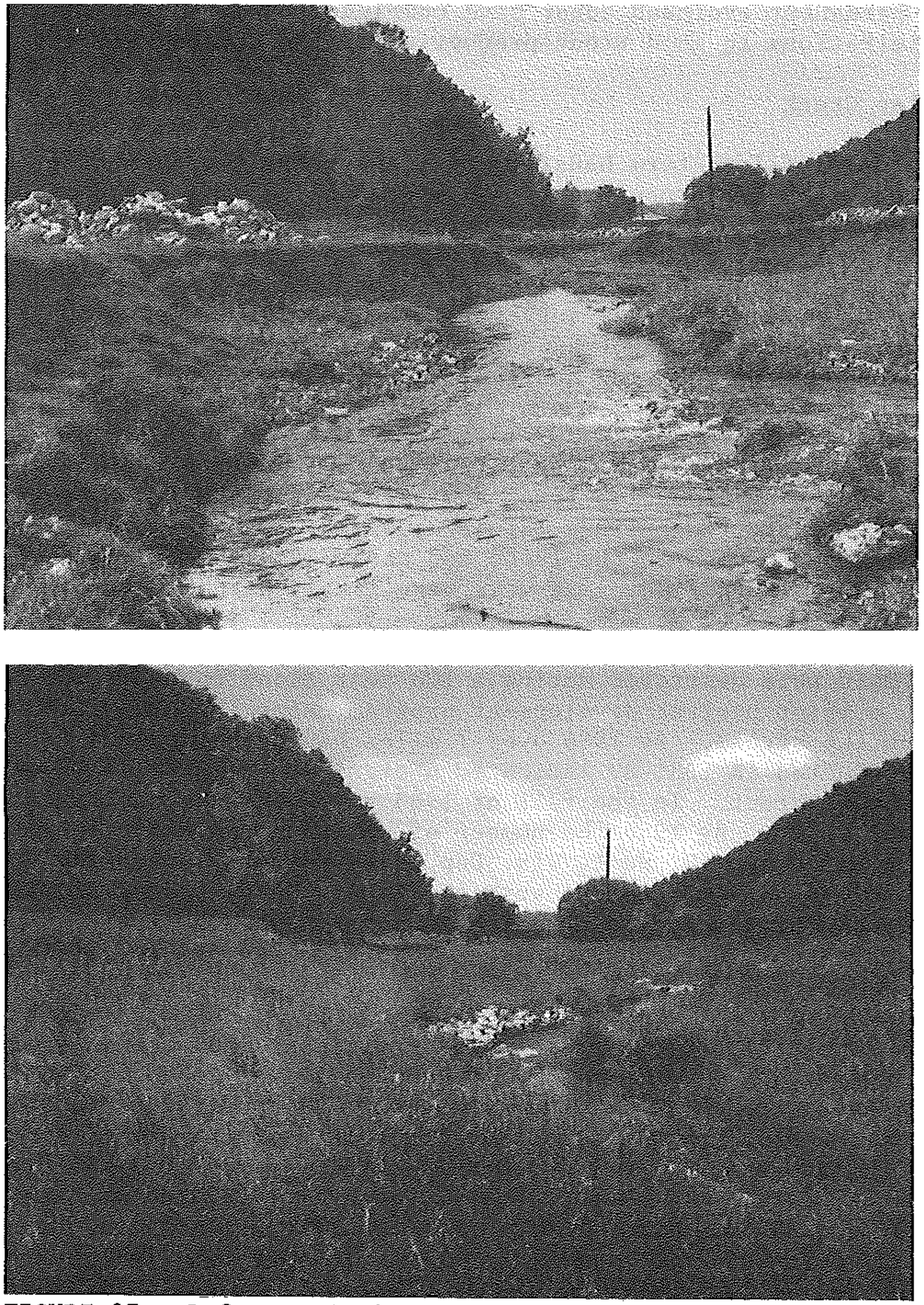


FIGURE 37. Before and after habitat improvement, Timber Coulee, Vernon County, 1985-86.

additional permanent overhead cover have combined to counteract most of the previous limitations to good trout production in the coulee streams.

Timber Coulee Creek

The best example of long term benefits of the habitat improvement program is Timber Coulee Creek in Vernon County. Almost 8 miles of its 8.2-mile length have been improved. In 1951, in a letter dated 1 March to Mr. Roy Smith of Cashton, Wisconsin, Elmer Herman, Area Coordinator for the then Wisconsin Conservation Department, wrote that "the [Timber Coulee] stream, at least in reference to the reconnaissance survey [of 20 June 1950], is no longer a good trout stream, and it should not be considered as such." Herman went on to state that, because of changing habitat, the stream was more adapted to warm water fish than to trout.

In 1956 an electrofishing survey of 14,295 ft of this stream yielded 70 brown trout. A 1967 survey of 30,145 ft of the stream provided 1,098 brown trout, of which only 15 were fingerlings. Since 4,000-12,000 brown trout were stocked annually in Timber Coulee in the 1960s and early 1970s, most of the fish recovered during electrofishing surveys were likely hatchery fish.

Some habitat structures were installed in Timber Coulee in the 1960s and 1970s, but most were destroyed during a 100-year flood in 1978. Following this event, a major habitat development program using LUNKERS units was initiated on the stream. By 1986 over 7 miles had been improved. Population estimates conducted in 1981-83 indicated a significant increase in native fingerling brown trout. In the fall of 1983 there were an estimated 4,000 native fingerlings. By 1986 the number of native brown trout fingerlings was estimated to be 10,300 (R. Hunt, Wis. Dep. Nat. Resour., unpublished data). Obviously the habitat improvement work in Timber Coulee made a significant difference, not only by providing overhead cover needed by adult trout but also by exposing suitable spawning areas that had been previously covered with silt.

During this same period there was also a significant increase in fishing pressure. During the 9-month fishing season in Timber Coulee in 1985, fishing pressure was estimated by creel survey to be 1,292 hours/acre (D. Vetrano, Wis. Dep. Nat. Resour., unpublished data). This estimate was 127% greater than the fishing pressure recorded on a 2.5-mile portion of Rowan Creek in Columbia County during a 9-month fishing season in 1979, and it is the highest intensity of use observed on any Wisconsin trout stream measured by this index (Larson 1982). In 1984 the harvest on a 1.6-mile stretch of Timber Coulee was estimated to be 196 lb/acre (Hunt 1985). That value was 3-4 times greater than comparable values for brown trout fisheries on four central Wisconsin streams (Avery and Hunt 1981) and 12-15 times greater than comparable values for brown trout fisheries surveyed on two northern Wisconsin streams (Avery 1983).

Even with this dramatic increase in fishing pressure, Timber Coulee still had significantly increased numbers of native trout. Because of this increase in abundance of native trout, the stocking of hatchery-reared brown trout in the stream was discontinued in 1986.

CONCLUSION

It is now clear that the coulee streams, when given adequate overhead cover, protection from flood damage, and increased stream bank stability, will reach high levels of natural trout productivity. The LUNKERS unit structures have addressed the problems associated with log deflectors and are at present the best habitat improvement design available in the coulee region.

Because of the ease of construction and installation of the La Crosse LUNKERS unit, as well as lower costs and maintenance needs, other organizations have expressed interest in the design. The State of Minnesota began using the units in their coulee streams in 1987, the State of Illinois has expressed an interest in using the LUNKERS in some of their warm-water smallmouth streams, and the U.S Department of Agriculture Soil Conservation Service has drafted a proposal to incorporate the unit structure design in their guidelines for county cost-sharing programs and future state or federal cost-sharing for private lands fish stream improvement. Although these structures were designed to be used in the coulee's rock-and rubble-bottom streams, they should be considered for use in any similar stream type.

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